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Forthcoming Events.

SEPTEMBER 6-18.
Universal Smoke Abatement Exhibition at Birmingham.
SEPTEMBER 13.
Institute of British Foundrymen (Lancashire Branch):—Visit to Messrs. Mather & Platt's Salford Ironworks.
SEPTEMBER 17-25.
Model Engineer Exhibition at Royal Horticultural Hall, Westminster, S.W.
SEPTEMBER 27-OCTOBER 1.
American Foundrymen's Association:—Congress at Detroit, U.S.A.
OCTOBER 4-9.
Motor Cycle and Cycle Exhibition at Olympia, London, W.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Foundry Trades Equipment & Supplies Association.
Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Payment by Results.

Many logicians insist that where an exact statement of a problem is available, the solution is near at hand. As an equitable solution is almost universally sought for the problem of paying foundry workers a saving wage which will bear a direct relationship to the character and amount of energy expended in the production of castings, we propose "to state the case" in order to lighten the burden of those seeking a remedy.

Piece-work probably forms the fairest basis upon which to construct any system of payment, as obviously remuneration varies directly with production, and the problem fairly well resolves itself into the establishment of an equitable basis price per unit to be wholly or partially manufactured.

From the employers point of view there are the following difficulties which are constantly arising:—(1) Inability to estimate sufficiently accurately without previous experience, the man-hours necessary for the economic production of any given casting; (2) the percentage of unavoidable wasters; (3) the maximum and minimum production that can be relied upon by the utilisation of the labour available; (4) the apportionment of any increased profit due to improved methods of manufacture, emanating (*a*) from the workmen's initiative and (*b*) from efforts made by the management; and (5) the obtaining and retention of the good will of the operatives.

From the worker's point of view, there are the following difficulties: (1) The establishment of a price which will make his efforts worth while; (2) lack of practical assurance that his efforts will not shorten his working week; (3) the debiting of waster castings for which he feels he is not responsible; (4) the lowering of unitary basis price; and (5) general trade-union antipathy.

The foundations of payment by results have been shaken from time to time by the employers by (1) instituting a lower unit price when only an immaterial change has been made in design; (2) by an inequitable division of profits when operating improved methods through the introduction of machinery; (3) by awarding insufficient credit when waster castings have been reclaimed; (4) unreasonably cutting established piece-work prices; and (5) as a last generalisation—favouritism.

On the workers' side, the system has been jeopardised by (1) neglecting urgent work offering less possibilities of increased revenue and concentrating on those which ensure a large yield; (2) relaxing effort if the early part of the pay-period has failed to yield more than his datal wage; and (3) refusing to accept a lower price, where faulty costing is causing, or has caused, a financial loss to the employer or prohibits future bidding for similar work.

For the carrying out of a piece-work system a number of basic principles must be accepted by both parties.

Primarily, the costing and estimating systems must be satisfactory to both parties. It must also be agreed that no limits must be imposed upon earnings of the workman or the profits of the employer; but they must bear an elastic relationship to each other.

Obviously, these two principles do not take the subject very far, but they strike at the root of the subject as with this knowledge available, both sides have concrete material upon which to build and gradually to eliminate existing snags.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Electrically Melted Cast Iron.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In your issue of August 5 you published a letter from Mr. C. H. J. Trutch, in which he gives some figures for the number of electric units per ton required to melt steel for castings in the electric arc furnace, and referring to the current consumption of 850 to 900 units per ton mentioned by Mr. R. J. Hyde in his Paper on "Improved Cast Iron." In this connection the following figures may be of interest:—

For some time past it has been the practice at the foundry with which the writer is associated to make special pig-iron by the electric furnace process in heats of three tons. The charge is composed of one quarter pig-iron one quarter steel scrap, one half steel turnings, together with the required amount of carburiser. The necessary ferro-alloys are added to the bath in the furnace immediately before pouring. No actual temperature determinations are available, but the iron is certainly as hot as good cupola metal. Under these conditions, the average melting time, from time of putting the current on to tapping, is two and a-half hours, and the average consumption is 625 units per ton.

The method of charging has a considerable influence on the time required per heat; presumably the sand on the pigs causes them to be poor conductors, therefore they must be charged in such a way that they do not interfere with rapid melting. Unsuitable disposition of the charge may account for an increase of as much as an hour in the melting time.—Yours, etc.,

C. C. HODGSON.

The Farington Steel Foundry of
Leyland Motors, Limited,
Leyland.

August 26, 1926.

The I.B.F. London Convention.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR—I append hereto the final list of donations received towards the expenses of the recent Convention in London. This list, together with the amounts previously acknowledged, totals a sum of £452 6s. 6d., which has covered all the liabilities.

I am asked to express through the medium of your Journal the best thanks of the Convention Executive to all who contributed to this financial success.—Yours, etc.

H. G. SOMMERFIELD.
Hon. Sec. and Treasurer.

Charterhouse Chambers,
Charterhouse Square,
London, E.C.1.

Aug. 27, 1926.

Amounts previously acknowledged, £362 16s.; British & Continental Traders, Limited, £26 5s.; Stanton Ironworks Company, Limited, £25; Constructional Engineering Company, Limited, £5 5s.; British Pigirons, Limited, £5 5s.; Thos. E. Gray & Company, Limited, £5 5s.; Frys' Metal Foundry, Limited, £5 5s.; Britannia Foundry Company, Limited, £5; J. Durrans & Sons, Limited, £5; Mr. M. J. Cooper, £1 1s.; Mr. H. O. Slater, £1 1s.; Mr. C. Cleaver, £1 1s.; Mr. A. H. Munday, £1 1s.; Mr. J. Bartram, £1; Mr. J. Lisby, 10s. 6d.; Mr. J. Kelly, 10s. 6d.; Mr. E. Bean, 10s. 6d.; Mr. C. F. Walker, 10s.

Total ... ... £452 6s. 6d.

MR. W. H. POOLE, Director of the Keighley Laboratories, has made a good recovery from his recent operation, and has now returned to business.

MR. GEORGE HALL has resigned his seat on the Council of the London Branch of the Institute of British Foundrymen, having been appointed foundry manager to Messrs. Jenkins Brothers, of Birkenhead. He has recently been acting in an advisory capacity to the British Perlit Company.

The Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C.

At the Sir John Cass Technical Institute, which is one of the London Polytechnics, instruction is given in pure and applied mathematics, physics, chemistry, the fermentation industries, petroleum technology, gas manufacture, metallurgy, foundry work, mining, arts and crafts, and modern languages.

In order that those who are engaged during the day may have the opportunity of obtaining an adequate education, the courses of instruction, which meet the requirements of those engaged in chemical, metallurgical, and electrical industries are held each evening from 6 to 10 p.m.

The session, which extends over about thirty-six weeks, will commence on Monday, September 20, and students will be enrolled on Wednesday, Thursday and Friday, September 15, 16, and 17, from 6 to 8.30 p.m.

Full facilities are provided in the well-equipped laboratories of the Institute for special investigations and research. The instruction in experimental science also provides systematic courses for the examinations of London University and the Institute of Chemistry.

Catalogues Received.

Cast-Iron Pipes.—The September monthly stock list issued by the Staveley Coal and Iron Company, Limited, is now available.

Power Transmission.—The Steel Band Conveyor & Engineering Company, Limited, of Barker Street Works, Parade, Birmingham, have sent us a novel form of catalogue. It consists of 18 pages which unfold and reveal it to be in reality just one large sheet. It has a disadvantage in that it is quite possible to miss some pages, and one side when opened out carries a portion of the text upside down. The catalogue is confined to describing and illustrating steel bands as used for power transmission purposes. There is no reference to their use in or about foundries, most of the examples given are for main drives in cotton, worsted, flour, paper and rolling mills. It would be interesting to learn as to their suitability of running in dusty atmospheres such as are sometimes to be associated with fettling and grinding shops. Notice is given of the availability of a folder on steel band conveyors, a proposition to which we attach the utmost importance for the foundry trades.

Examination and Analysis of Cupola Slag.

The author, Mr. H. H. Shepherd, draws attention to two mistakes existing in this article.

On page 99 appear figures indicating the composition of a slag giving good slagging and desulphurising conditions. The figures appear in the first column of the page, and read: (*a*) Not more than 50 per cent. silica; preferably less than 45 per cent. lime; not less than 0.35 per cent. magnesia. They *should* read: Silica not more than 50 per cent. and preferably not less than 45 per cent.; lime and magnesia not less than 35 per cent.

On page 162, in referring to the calculation of the magnesium present from the amount of magnesium pyrophosphate obtained, this should read simply: "Weight of magnesium pyrophosphate, minus weight of any found in blank, × 0.362 × 100, divided by 0.40" and not "weight . . . . . blank × 0.362 × 100, *multiplied by* 36.2."

The procedure for calculation of the results has in most cases been omitted as being too familiar to warrant reprinting, but I think it is worth while to draw attention to the facts that the iron oxide present is estimated as *ferric* oxide and that it is necessary to multiply the ferric oxide found by 0.90 to convert it to *ferrous* oxide, the condition in which the iron exists in the main in the slag. Further, in regard to the volumetric finish for the estimation of lime, it may be pointed out that each c.c. of N/10 $KMnO_4$ equals 0.0028 grams of lime (CaO).

European Foundrymen to be Honoured at the Detroit International Congress.

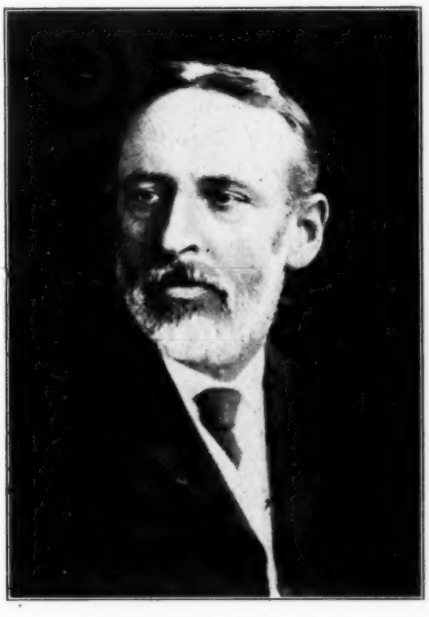
On the recommendation of the Board of Awards of the American Foundrymen's Association, the board of directors has approved the granting of gold medals to three prominent European foundrymen and metallurgists.

Monsieur E. V. Ronceray, of Thiais, France, has been chosen to receive the J. H. Whiting Gold Medal; Mr. John Shaw, of Sheffield, to receive the John A. Penton Gold Medal; and Professor Thomas Turner, of the University of Birmingham, is to be granted the Joseph S. Seaman Gold Medal.

The Board of Awards, in its recommendation, considering that the occasion of the granting of these awards is to be the Second International Foundrymen's Congress, selected three men who have been most prominent in European circles in their contributions to the advancement of the foundry industry. Professor Turner is one of the British metallurgists whose work has been of fundamental importance to the casting industry. Mr. Shaw, a foundryman and student of cast metallurgy, has been very influential in the development of British foundry practice. M. E. V. Ronceray is recognised as being the foremost French foundryman, who has been instrumental in the development of French foundry practice. He was an organiser of the French foundry school and a manufacturer of moulding machines which have largely aided French foundries to be put on a production basis.

MONSIEUR E. V. RONCERAY

who is the recipient of the J. H. Whiting Gold Medal.



PROFESSOR THOMAS TURNER

who is to receive the Joseph S. Seaman Gold Medal.

The American Foundrymen's Association medals which are to be presented to these men at the Thirtieth Annual Convention of the American Foundrymen's Association and Second International Foundrymen's Congress to be held at Detroit the week of September 27 to October 1, are three of the four gold medals authorised by the Association for presentation from time to time to outstanding men connected with the foundry industry. The medals were made possible by gifts to the Association, contributed by four charter members and past officers of the Association: John A. Penton, first Secretary; Joseph S. Seaman, the third President; W. H. McFadden, the tenth President; and John Hill Whiting, Vice-President in 1906.

The presentation of medals will be made at the annual banquet, Thursday evening, September 30, of convention week.

Monsieur E. V. RONCERAY.

Eugene Victor Ronceray, who is to be granted the J. H. Whiting Gold Medal of the American Foundrymen's Association at the 1926 Detroit meeting, is president and managing director of S.A. des Etablissements Bonvillain et Ronceray, Choisy-le-Roi, near Paris. He also is chairman and managing director of the Universal System of Machine Moulding and Machinery Company, Limited, of London, and director of studies at the Foundry High School of Paris.

M. Ronceray, born November 15, 1869, took his engineering degree in 1891 at the Ecole Nationale des Arts et Metiers, of Chalons. From 1891 to 1897 he was professor at the Institution Parangon, near Paris, where he was at first educated, and he prepared students desirous of following the course of the National Schools of Arts and Manufactures. In 1897 he took a post with the Paris-Lyon-Mediterranee Railroad. Later he became connected with M. Bonvillain, with whom he established the first manufacture of moulding machines in France. He became manager, and then managing director of the company.

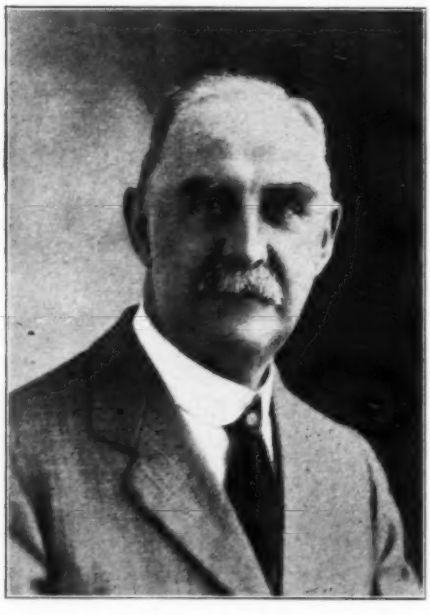
M. Ronceray has devoted the greater part of his life to foundry practice. He is one of the founders of the Association Technique de Fonderie de France, of which he is vice-president, and has been member of the council since its foundation. He has contributed a considerable number of articles, papers and lectures. In the United States he lectured in 1907 at Pittsburgh, Boston, New York, Providence, illustrating his subject with moving pictures. He presented a paper at the Foundrymen's Congress in Philadelphia in 1907 and at the Rochester convention in 1922, and took an active part in the various conventions of foundry associations in Belgium, Great Britain, Czecho-Slovakia and France. He was on the organising committees of various foundry exhibitions and conventions, including the exhibition of Torino, Italy, in 1911, and the international congress in France in 1913 and 1923. Since 1923 he has been chairman of the Committee of Papers of the French Foundry Association.

In 1921 M. Ronceray originated the idea of a special foundry school in a lecture which he delivered in Liége, Belgium. Three years later the first foundry school was inaugurated in Paris.

During the international congress of Paris in 1923 he created the international committee in charge of new testing methods of cast iron, with representatives of America, Belgium, Czecho-Slovakia, France, Great Britain, Italy, Spain and Switzerland. He is a member of many scientific and technical institutions, including a charter membership in the American Foundrymen's Association, an honorary member of the Institute of British Foundrymen, and member of the council of various economic and industrial organisations, a Chevalier of the Legion of Honour, and a Chevalier of the Royal Order of Charles III of Spain.

Professor THOMAS TURNER.

Thomas Turner, to be granted the Joseph S. Seaman Gold Medal of the American Foundrymen's Association, has until his recent resignation been Professor of Metallurgy, Birmingham University, Birmingham. Professor Turner is known to foundrymen the world over for his research on the influence of silicon on cast iron. He also has done much useful and important work in the field of non-ferrous metals. It is due to the energy and able work of Prof. Turner that the



MR. JOHN SHAW
who has been awarded the John A. Penton Gold Medal.

metallurgical school at Birmingham University has attained prominence.

Prof. Turner was born in 1861, educated in the schools of Edgbaston, and was graduated from the Royal School of Mines, London. While he kept closely in touch with commercial, metallurgical and foundry problems, these interests never resulted in the neglect of the purely teaching side, and he is well known as an able lecturer.

He has written several books on metallurgy, the first in 1895, "Metallurgy of Iron," followed by "Lectures on Iron Founding," and "Practical Metallurgy." In addition to these, he has published over a hundred papers on metallurgical and educational subjects. Prof. Turner was presented with the Bessemer Gold Medal in 1925 by the Iron and Steel Institute in recognition of services to the iron and steel industry. As a further mark of esteem the University of Birmingham awards the Thomas Turner Gold and Bronze Medals for prizes in metallurgical work done by the students. Professor Turner has contributed papers before the meetings of the American Foundrymen's Association, and was made an honorary member of this Association in 1901. Professor Turner is a member of the Iron and Steel Institute, Past-President of the Institute of Metals, member of Institute of Mining and Metallurgy, honorary member of the Institute of British Foundrymen, and many other organisations. Professor Turner has recently announced his retirement from active university work.

Mr. JOHN SHAW.

Mr. John Shaw, who is to receive the John A. Penton Gold Medal of the American Foundrymen's Association at the Second International Foundrymen's Congress, is one of the foremost British foundrymen who has contributed extensively to the technical Press on practical and metallurgical phases of the foundry industry.

He was educated at the Farnworth Grammar School, Widnes Technical School, and Liverpool University. After completing his education, Mr. Shaw served his time as apprentice with the Widnes Foundry Company, and owing to his ability was made assistant foreman at the age of 19. He was in full charge of a foundry at 22. After six years in charge of a small foundry in Wales, he became foundry manager for Cochrane & Company, Limited, Dudley. During the war Mr. Shaw was director of the grey iron castings section of the Ministry of Munitions. For the past several years he has been manager of the Newhall works of the Brightside Foundry and Engineering Company, Limited, Sheffield, in which plant iron castings up to 120 tons in weight have been made.

Mr. Shaw has been prominently identified with foundry organisation affairs for many years. He joined the Institute of British Foundrymen in 1906. He was President of the Birmingham Branch for three years, and President of the Sheffield Branch. He is the third oldest British member of the American Foundrymen's Association, which he joined in 1910. Mr. Shaw represents the Institute of British Foundrymen on the international committee appointed to work out standardised tests for cast iron. He is also the delegate of the Institute of British Foundrymen to the British Engineering Standards Association.

As a fitting tribute for his distinctive and valuable services to the foundry industry of Great Britain Mr. Shaw was presented with the Oliver Stubbs Gold Medal at the 1924 meeting of the I.B.F. Mr. Shaw has been selected to present the 1926 Exchange Paper on behalf of the Institute of British Foundrymen, to be presented before the Detroit meeting of the A.F.A.

Patent Specifications.

The following list of patent specifications accepted have been taken from the "Illustrated Official Journal (Patents)." Printed copies of the full specification can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each.

8,257. BECHARD, E. Means for connecting metal pipes. March 27, 1925. 253,635.

9,730. KORSUNSKY, M. G. Manufacture of alloys. April 14, 1925. 254,042.

31,131. MICHELIN ET CIE. Metallic wheels for vehicles. Aug. 29, 1925.

8,517. SCHOLEFIELD, E. Jar-ramming moulding-machines. March 31, 1925. 254,378.

8,931. BETHUNE, G. DE. Apparatus for the introduction into furnaces and blast furnaces of materials or residues. April 3, 1925. 254,396.

9,636. KENNARD, G. W., KENNARD, W. E., and KENNARD, J. E. Annealing-boxes. April 14, 1925. 254,419.

11,553. KOHLENSTAUB GES. Apparatus for supplying coal dust to furnaces by means of compressed air. (May 7, 1924.) 233,696.

10,908. DAVIES, JUN., C. Manufacture of pig-iron. April 27, 1925. 254,442.

14,873. POTTER, W. W. Machine tools for turning or cutting metals (March 28, 1925.) 249,799.

15,122. WELLMAN SEAVER ROLLING MILL COMPANY, LIMITED, and SMITH, S. Pilgering-mills. June 10, 1925. 254,483.

16,360. SETTEN & DURWARD, LIMITED, and SETTEN, R. S. Machine for manufacturing tubular articles from strip. June 25, 1925. 254,504.

8,712. HOWARD, LIMITED, J. & F., and SHORTEN, J. G. Casting-apparatus. April 1, 1925. 254,777.

8,719. HOWARD, LIMITED, J. & F., and SHORTEN, J. G. Machines for forming moulds. April 1, 1925. 254,778.

9,582. DOWNING, A. G., and DOWNING, H. N. Moulding and casting of metal bodies. April 9, 1925. 254,810.

21,880. HOWARD, LIMITED, J. & F., and SHORTEN, J. G. Casting-apparatus. April 1, 1925. (Divided Application on 254,777.)

21,883. HOWARD, LIMITED, J. & F., and SHORTEN, J. G. Casting-apparatus. April 1, 1925. (Divided Application on 254,777.) 254,905.

The German Foundry Owners' Association.

Some Results of Tests on Fire Bars.

At the annual meeting of the Verein Deutscher Eisengiesereien Giesserei Verband, held last Thursday in Berlin, three technical Papers were submitted, abstracts of which we give below.

Fire bars can be classified in accordance with their physical properties, structure, and analysis. In regard to physical properties no data are to be found in print, and only a few particulars are available concerning chemical composition. These particulars, moreover, are in contradiction to the composition of the fire bars in actual use. Information as to the structure of fire bars and the changes it undergoes is given in two Papers recently published, by Hopfelt ("Steam Boiler Grate Fire Bars with Protective Covering": Zeitschrift d. V.D.I., 1926, No. 13, page 411), and Stumper ("Fire Bars and their Reaction to Fire": Giesserei, 1926, No. 4; Giesserei, 1925, No. 5). The results of the researches made by these two investigators are, however, at variance in some respects, and in others are flatly contradictory. The State Railways, in collaboration with foundry experts, have also carried out tests with fire bars at the Engine Testing Shops and the Mechanical Testing Department of the Central Railway Offices in order to obtain data for their classification and the laying down of test conditions. Fire bars containing 0.25, 0.40, and 0.65 per cent. phosphorus were used for the purpose, as well as the bars ordinarily employed in practice containing about 1 per cent., and bars with a hardened surface and protective covering. The bars were subjected to structural tests and chemical analyses both before and after being built into the engines. The result was that they were found, when under the influence of heat, to undergo far-reaching alterations in structure, extending in some instances to the whole of the bar, as can be seen from a series of photographs of the structure. We can observe in the first place an upper reaction zone, which under working conditions is obviously in an almost fluid state. This zone is the only one into which the sulphur from the coal penetrates. Values as high as those given by Stumper were not obtained, the figures recorded approximating more closely to those quoted by Hopfelt. Next to a transitional zone, which shows a varying structure, there comes a specially well-defined zone, in which the structure—mostly pearlitic—of the fire bar has for the greater part, under the influence of heat, been converted into ferrite. From the dimensions of this zone, which is constituted quite differently in the individual bars, an idea can be formed of the stresses to which the bars as subjected under working condition. In bars with protective covering the transformation phenomena observed were analogous to those noticed in bars without this protective covering. The ternary phosphide eutectic begins to disappear under the influence of heat in the upper zones of the fire bar. It was shown by means of etching that in the first place the ledeburite constituent dissolves, while the phosphide element remains intact for a considerable time. About 2 to 3 cms. from the fire surface only light traces of this constituent can be observed. The actual breaking-up process of the fire bar, however, only begins in the zone in which the melting temperature is approximately reached. To what extent the constituents of the coal ash, which is much more fusible than cast iron, help to dissolve the cast iron, lower its melting point, and therefore promote its disintegration, it is impossible to say at present. It is, however, possible that we here have to deal with a much more potent cause of the destruction of fire bars than can be found in the structure and composition of the bars themselves.

It should further be pointed out that it is exceedingly difficult to obtain uniform test results. Sometimes only one out of a set of bars is destroyed, without any differences being apparent either in structure or otherwise. More than this, successive different stages of disintegration can be observed in one and the same grate bar. It is therefore easy to draw incorrect inferences from single tests.

The Present Position of Drying Stoves for Iron and Steel Moulds.

Herr Erbreich took as the starting point of his address the results of the Hamburg Exhibition of 1925. In a memoir then issued the heat balances of various drying stoves were published. The most important point determined were (*a*) the charging of the ovens, and (*b*) the verifications of the heat consumption necessary for the evaporation of the water. As a result of these researches the Krupp-Grusonwerk in Magdeburg was led to alter its drying ovens, on the one hand, increasing the charging of the ovens to a maximum, on the other, and thereby effected a financial saving of 89 per cent., as compared with the pre-war consumption. The Krupp-Grusonwerk had a hygrometer constructed with considerable difficulty and incorporated in the drying ovens. The figures thereby obtained showed that the air introduced into the chambers by the forced draught was much too little saturated with moisture, and therefore carried off heat into the chimney unnecessarily. Following upon the tests, counter-tests were carried out in a stove at the Tanger Foundry, when the following conclusions were reached:—

(1) The complete combustion of the fuel must be attended to. The old coke baskets or the like must therefore be abandoned and forced draught introduced.

(2) The temperature must be increased as rapidly as possible so as to reduce the heat losses as much as possible.

(3) The ovens and oven doors must be well insulated.

(4) It is essential to incorporate pyrometers.

(5) Firing must be continued sufficiently long and in such a manner that after it is finished and the ovens are closed a temperature of at least 100 deg. C. shall still predominate in the ovens next morning, for the drying of the mould requires a certain time.

Recently, therefore, the practice has been adopted of equipping drying stoves with regenerators. Herr Erbreich gave a description of a stove of this type by Messrs. Hermann & Söhne, Frankfurt a. M., and another used in a "Perlit" foundry.

In order that the gases may circulate uniformly in the drying chambers the gas flue must be placed beneath the hearth. In proof of this the experiments of the French Professor Debar, published in "La Fonderie Moderne," were cited.

Herr Erbreich also discussed the subject of core-drying stoves, mentioning as novelties the stove of Messrs. Flender & Company, of Bocholt, and the drying soaking-pit of Engineer Schmid. He drew attention to the prize competition work at present being done in connection with drying stoves, and in particular to the comparative work carried out in regard to floor drying-ovens, by which it had been shown that portable ovens employing compressed air and a powerful blast have given the best results. A number of photographs relating to American drying-stove plants were shown.

The Determination of Piece-Work Time by Time and Work Studies.

BY DR. LISCHKA, Düsseldorf.

The keenness of competition and the continual improvements that are being introduced into working methods have, according to Dr. Lischka, rendered the determination of piece-work rates by means of the estimates of foremen, preparers or works managers insufficiently accurate. In foundry work, time and work studies are also beginning to be adopted for the accurate determination of piece-work time. To promote such efforts the German Foundry Owners' Association has constituted a committee which is making a thorough examination of the question. The result of co-operation with the Reich Committee in connection with time studies goes to show that the knowledge hitherto acquired—which was mainly

obtained in connection with lifting type moulding machines—can also be applied here. The result of these investigations is embodied in a series of "Refa" papers, which will be found useful in practical work and in the training of those responsible for estimating piece-work time.

The first paper deals with the various classes of preliminary work which may be given out in the foundry by the piece, viz., moulding, core making, casting, stripping and cleaning. The piece-work is arranged individually or by groups according to the system followed in the works. The total time for each individual piece-work job must be divided into preparation time and piece time. The preparation time is further divided into preparation time proper and lost time, and the piece time into basis time and lost time. The basis time is subdivided into principal time, fatigue time and subsidiary time. The relation of the individual operations to the different times is shown by means of examples, so that the definitions are clearly comprehensible. An example also shows the systematic division of a requisition for preliminary work into preliminary plan, progress and stages of work, handling and details of handling. Similarly, the process of estimating is illustrated by an example relating to hand moulding and another to machine moulding. A special sheet contains general and detailed information regarding actual time-recording: its general idea, purpose, form, calculation, utilisation and sphere of application. Stop-watches are chiefly employed as aids. Professor Poppelreuter's work-recording clock promises to prove very useful in many cases. It permits of simplified observation by the personal action of the time-taker, as well as by automatic registration on the part of the worker, while it also records on the spot and at a distance. The diagrams obtained by this system can be utilised in the form of graphs or arithmetically. A particular example—that of clamp plates, bottom box moulding—is dealt with in two observation sheets for time recording before and after the systematisation. The forms used are standardised for hand and machine moulding, and can be obtained from the Beuth publishing house. The observation sheet for work recording also contains an example—the templet moulding of a piston. The observation sheet for lost time enables these categories of time to be clearly and conveniently grasped. Special sheets have been designed for working out the results in machine and hand moulding. The additions constitute a special chapter, these being subdivided into working time, fatigue time and lost time additions. Additions for other numbers of articles than those upon which the previous calculation was based must be specially taken into account in the same way as those for extra work or rejection risks. The checking of these additions is, moreover, very important. Further research work is in progress dealing with the determination of the fatigue additions and their graphic representation.

By this research work a systematic basis for the determination of piece-work time in foundries has been established. Although changes may be necessary as a result of further investigation and the modification of details, and although individual works may employ slightly different methods owing to particular methods or conditions of work, these researches constitute a great advance towards perfecting the determination of piece-work time in foundries. The advance will be the greater in proportion as foundries adopt the process, and thus contribute to the improvement of the methods and the advancement of the foundry industry in general.

IT is understood that a second plate mill has been restarted at the Clarence Works of Messrs. Dorman Long & Company. At their Redcar works the firm intend to restart three steel furnaces and a plate mill.

IT is understood that Messrs. Wm. Gray & Company's shipyards at West Hartlepool will resume work almost immediately. Owners for whom tonnage is building have agreed to waive the clause that only British material shall be used, and the firm are importing supplies from abroad. A cargo of steel is already on its way from the Continent, and coal supplies have been ordered from the Continent and from America.

Book Review.

Refining Metals Electrically.—By Larry J. Barton. Published by The Penton Publishing Company, 2-3, Caxton House, Westminster, S.W.1. Price 30s., post free.

Primarily we do not care for the title of this book, as it does not adequately describe the contents. A better title, to our mind, would be of a more limiting character; for instance, we believe "The Electric Furnace in Ferrous Foundry Practice" would be preferable. In a book bearing the title "Refining Metals Electrically," one expects to find information relative to brass, bronze, aluminium and hosts of other metals and alloys, which are not included.

A mistake appears in Table I, which is taken from the "Iron Age" and purports to give the comparative output of electric steel. It says definitely that no electric steel was made in Great Britain in 1913. We admit that the output was not large, but electric steel was being made by Firths, Vickers, Edgar Allens, Lake & Elliot, Kayser Ellison, and the Warren Street, Sheffield, furnace. We suggest that in future editions a dotted line should appear, as has been done with Italy.

Though Chapter II deals with costs under American conditions, many of the conclusions apply equally well on this side. In one particular, however, it will be found to be quite different, that is, so far as labour costs are concerned. According to the author, a 3-ton furnace only costs 3 cents per ton less for labour than a 1-ton. Again, in the States the cost in refractories is assumed to be the same in both large and small furnaces. This does not conform to the reviewer's experience. We were interested to learn, on page 37, that the Greaves-Etchells' furnace is unique in that it uses the principle of the conducting hearth, implying basic operation only, as an acid refractory will not conduct the current. Actually the reviewer has worked two other well-known types of furnace incorporating conducting hearths, whilst he seems to remember an acid-lined Greaves-Etchells' furnace in Barnsley working quite successfully.

For the practical man it is fascinating to read how Americans line their basic electric furnaces. Apparently dolomite is not used, magnesite being preferred. A paragraph stating that open-hearth slag was sometimes used brought to mind an experiment the reviewer carried out in the very early days of electric furnaces. Basic open-hearth slag was used. Everything went well until the institution of reducing conditions, when the incorporated slag decided to yield up sufficient phosphorus to ruin an otherwise perfectly good cast.

We attach a good deal of value to Chapter V—"Lining the Acid Furnace"—as it is difficult to find printed information on this particular phase of furnace practice, whereas the Chapter VI, which deals with the purchasing of scrap and charging, contains but little of interest to European readers.

The author is obviously thoroughly at home with the practical handling of furnaces, and those in charge of furnaces will be in agreement with the many useful suggestions put forward. Thus the chapters devoted to this, the most important phase of metallurgy, are well worth study, especially the three devoted to alloy steels. To the melting of grey iron the author devotes two chapters. As only three foundries in Britain are practising this, the information given is of a unique character.

The subject of ladles is entered into in detail, and is of real interest to wider range than those to whom the book is primarily addressed. The final chapter is "Cost Data," which presents many useful pointers. For instance, a 6-ton acid furnace making 45 tons synthetic cast-iron daily takes 525 kilowatt hours per net ton.

The book contains a large appendix which sets out a number of log sheets of great practical utility. Finally, there is a well-chosen bibliography, except that the symposium organised by the Institute of Electrical Engineers is omitted. We deplore that all the temperatures are given in Fahrenheit. Whilst we do not wish to impose British ideas on the American public, the fact does stand out that they are the only nation left who think in Fahrenheit for metallurgical work

Institute of Metals.

The autumn meeting was opened last night in Liége by the presentation of the fifth Autumn Lecture by Dr. W. Rosenhain, D.Sc., F.R.S., who took for his subject "Modern Metallurgy and Ancient Industries," of which we give below a lengthy abstract.

Modern Metallurgy and Ancient Industries.

Place of Secret Processes in the Evolution of Metallurgy.

From the crudest beginnings the practice of metallurgy has gradually developed by a process carried on from generation to generation. While the ordinary workman or craftsman would be content to imitate as exactly as he could the processes and results learnt from his father or from older workers, here and there an enterprising individual might be tempted to try an innovation or, by observation, might be led to utilise some accidental result for the improvement of his product. This process of development by trial and error, by the observation of accidental happenings and, very occasionally, by deliberate introduction of new ideas, taking place over hundreds or even thousands of years and engaging the minds and activities of a multitude of workers, has led to the accumulation of a great mass of skill and experience. An industry developed in this way is full of special and often more or less secret processes. Parts of these are essential to success, while others may be either entirely unnecessary or even detrimental. Those who practise the art, however, cannot discriminate between the necessary and the unnecessary, as they have no basis of general knowledge upon which to form such a judgment. None the less, within the limit and scope of what has actually been achieved, the art developed by such a process attains a considerable degree of perfection. Some of the metal products of classical antiquity show the high degree of skill which had been attained in those early times, long before any attempt at a scientific understanding of the processes involved in the reduction and treatment of metals had been made.

External Aids to Progress.

It is only at a comparatively late stage in the development of an industry or art that a scientific basis is sought for the operations previously carried out in a rule-of-thumb manner. That attempt, moreover, comes not from within the industry but from without. Scientific investigators have established a number of general principles of chemistry and physics, and an attempt is made to apply these principles to the better understanding of the processes used by the metallurgist. At quite an early stage of this process there is a crop of fruitful results. The scientific investigator, working in the laboratory, is enabled to make comparatively rapid progress in his study of the laws of nature by simplifying in an artificial manner the phenomena which he has to study. He is able, by means of his apparatus, to isolate the particular kind of happening or the particular property which he wishes to study, and is thus enabled to arrive at exact and conclusive results. The laws which he can thus establish in the laboratory must, of course, be equally applicable in the world outside, including the furnaces and workshops of the metallurgists. But, when the attempt is made to apply these laws to practical processes, difficulties are inevitably experienced. The forces at work in the furnace and the forge, the properties which have to be studied or obtained in our metals, cannot be isolated and reproduced one by one. A highly complex set of conditions has to be met and controlled. The scientific investigator seeking to apply his principles finds at every turn that further fundamental knowledge is required. Almost every application of the known principles of science must be qualified with the reservation that the result aimed at will be obtained only so far as complicating causes will permit.

Copper Alloys.

In the story of prehistoric man, the bronze age is generally placed before the age of iron. Whether or not we accept this view, there can be no doubt as to the antiquity of copper alloys and even of copper itself. We may rightly, therefore, take the industry of copper and its alloys as typical of an ancient industry. Further, it is probable, if not certain, that some alloys of copper, such as bronze and brass, were produced and used by man long before pure copper was obtainable, although it may be necessary to exclude, from this point of view, the comparatively small quantities of copper which were found from time to time in a native state, more or less pure. The artificial production of nearly pure copper from its ores certainly represents a later stage in metallurgical history than the production of some of the alloys of copper with tin and zinc. This point is interesting because it is typical of the history of the development of most branches of metallurgy. Not only prehistoric metallurgists, but much later workers in that field found it easier to produce alloys than pure metal. The advance of metallurgical science has led to the production of metals in increasing purity, and that such degrees of purity as are now commercially obtained could never have been reached but for scientific development.

The early production of copper alloys by man must have been the result of the reduction of mixed ores, probably of the carbonate or oxide type, by means of fire and charcoal. No means of closely controlling the quality of the resulting product were available, and the uniformity of the results obtained must therefore have been dependent upon the uniformity of the ores worked upon. It is in this way, to a large extent, that the high reputation which certain localities enjoyed in antiquity for the production of various metal articles must have arisen. After a time, of course, there would also be a local concentration of knowledge and skill, often passed on from father to son.

One of the effects of modern scientific methods is to dispel the idea of inherited skill or knowledge so that, provided that those in control of the industry understand its principles thoroughly, it is by no means difficult to train new workmen to carry out the various operations in new localities. For this reason and for economic causes which outweigh considerations of localised skill in the selection of sites for industry, many of the traditional sites of metallurgical industry are finding themselves in strong competition or even superseded by new centres where the industry is growing rapidly under conditions more favourable than those which existed in the ancient centre. This is an effect of modern scientific development upon ancient industry which may perhaps be deplored in the interest not only of historical continuity, but because it so adversely affects the workers in many formerly important industrial areas. It is, however, perfectly open to those controlling the industry on its ancient site to meet the completion of newly-developed industries in other places by special methods. On the side of an ancient industry it should be possible to develop the production of materials of especially high quality or of particular properties required for special uses. Specialised local production of this kind often makes it possible to maintain an industry upon an ancient site where the acute competition of other places makes it impossible to continue the ordinary production of the cheaper quality of material. It would not be difficult to quote examples in Europe where developments of this kind have occurred, and it is indeed very necessary for those controlling metallurgical industries of long standing to maintain careful watch upon existing conditions and to see that the particularly high quality of their products is not surpassed elsewhere.

Natural Alloys.

The copper industry began with the production of so-called natural alloys, and it has sometimes

been suggested, and is still at times maintained, that there is a particular advantage about the production of a natural alloy, and that such alloys are in many ways superior to those which can be produced by synthesis, that is, by melting together the pure materials. Probably such a contention is entirely wrong. Once an alloy has been properly melted and well mixed, there can be no difference in the resulting material, whatever the source from which the original metals have been derived. This statement, however, must be taken in a strictly literal and accurate manner. For example, a "natural" alloy consisting mainly of copper and tin might, in practice, prove to be very different in its behaviour and properties from an alloy consisting of pure copper and tin prepared in the same ratio as those existing in the "natural" alloy. The difference, however, would not be due to the fact that one alloy was "natural" and the other synthetic, but to the fact that the second or synthetic alloy had not strictly the same composition. Modern research has shown so clearly the great effects which small impurities or additions can produce in pure metals and alloys, that we cannot afford to neglect these as appreciable constituents of so-called "natural" alloys. If, therefore, a "natural" alloy is found to be of complex composition, it may not always be sufficient, in reproducing it synthetically, to melt together the two or three main constituents. Careful examination is required in order to ascertain which of the minor constituents may be of importance. On the other hand, it must also be realised that many of these so-called minor constituents or impurities in natural alloys are deleterious, and that their elimination in the synthetic product leads to improved properties. At all events there can be little doubt at the present time that the era of "natural" alloys is rapidly coming to a close. Advancing knowledge of the effects of various constituents makes it increasingly possible not only to reproduce the properties of the best of the "natural" alloys but to prepare materials exceeding those properties in the desired direction.

The suggestion is sometimes made that in a natural alloy the metals are more intimately combined than when the material is prepared synthetically. There is, however, no justification for such a claim. Unless entirely unsuitable mixtures are used, there is nothing easier than to produce complete mutual solution of molten metals in one another. Particularly in the case of copper, alloys with zinc, tin, nickel, etc., are most readily prepared and extreme uniformity of composition can be obtained in a short time by suitable stirring, etc. It is true that some manufacturers think it desirable to remelt their alloys several times before making castings. It may be that some advantage can be gained by such an operation, but this is probably to be ascribed to the elimination of gases and not to the more intimate mixing of the alloyed metals.

Replacing Natural Alloys.

The progress implied in the production and use of approximately pure metals in place of "natural" alloys has been continued in recent years, under the influence of scientific and metallurgical developments, in the direction of the production and employment of metals of exceedingly high purity. This has, perhaps, been nowhere pushed further than in the case of copper. The older methods of copper refining by means of furnace treatment, leading to the production of those varieties of copper which are known in England as "best selected" and "tough pitch," result in a grade of copper which in favourable circumstances, is capable of giving excellent mechanical results, combining great toughness and ductility. The advent of the electrical industry, with its enormous demand for copper and its exacting conditions as to electrical conductivity, however, has led to a further development. It was soon discovered that the electrical conductivity of copper is very adversely affected by the presence of minute amounts of particular impurities, such as arsenic and iron, which are never entirely absent in copper which has been produced by furnace refining. Fortunately, the electrical industry, at the same time as producing the demand for high conductivity copper of extreme purity, has also provided the means for its preparation by electrolysis. The electrolytic refining of copper has rapidly grown until at the present time a large proportion of the world's output of copper is treated in this manner. The direct product of electrolytic refining, known as cathode copper, is a material of exceedingly high purity. Apart from the enclosure of small quantities of the fluid electrolyte, generally sulphate of copper solution, in which the copper is refined, impurities are practically absent. Unfortunately the copper cannot be used either for electrical or most other purposes in the form of cathode in which it is obtained from the electrolytic refining bath. It has to be remelted and cast into ingot form. In doing this, unfortunately, the copper absorbs impurities, mainly derived from the furnace gases. These are principally oxygen and sulphur. Further furnace refining operations have therefore to be used in order to eliminate, in the first place, the sulphur, by oxidation. This process, known in American practice as "flapping," leads to the production of a bath of molten copper containing a large proportion of oxygen. Now, oxygen itself is an impurity which produces undesirable results when too much of it is present in copper. It has recently been shown by research carried out at the National Physical Laboratory on behalf of the British Non-Ferrous Metals Research Association, that in copper, otherwise entirely free from impurities, the presence of any oxygen is undesirable; and, for many purposes, the lower the oxygen content can be brought the better the resulting copper. In technical practice, however, one has rarely to deal with copper as pure as this, and, further, the very method by which the oxygen content is reduced is liable to introduce impurities. These may consist of gases such as hydrogen, or, posssibly, of a certain amount of sulphur, which are derived from the wood or other material introduced into the molten copper in order to reduce the oxygen content in the process known as "poling." Consequently it is not possible to carry deoxidation to the limit, but a certain amount of oxygen must be left in the copper, where it remains in the form of oxide, in order to secure the maximum degree of toughness and soundness of the material. Treating the copper so as to bring it into this condition is well known as the operation of bringing the metal "up to pitch."

When all these processes are carried out as carefully and accurately as possible, the resulting copper is a material of very high purity. It may contain as little as 0.01 per cent. of oxygen, and the total remaining impurities may not be more than 0.06 per cent. In this form it is particularly useful owing to its high electrical conductivity. While the electrical uses of copper are perhaps more exacting in their demands upon purity than any other applications of that metal, there can be no doubt that there is at the present time a strong tendency, based upon the results of scientific experiments, and confirmed by practical experience, to insist upon very high purity even when the copper is used in the production of alloys valued for their mechanical properties. In the manufacture of cartridge brass, for example, a high standard of purity is demanded, since it is known that the presence of small amounts of such substances as antimony may materially influence the properties of the resulting brass.

Influence of Impurities.

Broadly speaking, impurities may take two distinct forms. Some of them, owing to the difficulty with which they can be taken up by the crystals of the parent metal, form separate constituents which can be readily identified under the microscope, even when only quite small amounts are present. Bismuth is perhaps the most striking example of this kind of impurity in the case of copper. Owing to the fact that bismuth takes the form of minute films or cell walls lying in the boundaries between adjacent copper crystals, its presence rapidly destroys the mechanical cohesion of the metal and renders it weak and brittle. On the other hand, since it does not enter to any appreciable extent into the structure of the crystals of copper themselves, it does not disturb their internal arrangement very much, and so does not interfere seriously with their power of conducting electricity. Oxygen is an impurity which behaves in a similar manner,

being present in copper in the form of cuprous oxide (Cu_2O), which forms with copper what is known as a typical eutectic alloy.

Arsenic is typical of the second class of impurity. Here the atoms of the impurity are more readily adaptable to incorporation in the crystal structure of the copper itself, and, as a result, when the amount of arsenic present is small, it cannot be detected as a separate constituent under the microscope, but exists in the most intimate mixture, or, as it is called, solid solution, in the crystals of copper. The consequence is, in this particular case of arsenic and copper, that the mechanical properties of copper are not adversely affected until the amount of arsenic becomes considerable. On the other hand, the effect on the electrical conductivity is very great, because the presence of the arsenic atoms in the crystals themselves destroys the complete regularity of their structure and interferes with the passage of the electrons which carry the electric current.

Necessity for Pure Zinc.

The demand for metal of very high purity makes itself felt not only in the material which is to be used in that pure condition, as for electrical purposes, but also in the production of alloys, in regard to copper and to other metals. Among these, zinc is perhaps the most important in the metallurgical industries and interests of Liége and its neighbourhood. For a long time the production of zinc has been carried on in Belgium and elsewhere by the well-known distillation process. It is also well-known, however, that the zinc produced in this way, although the best qualities attain a high degree of purity, cannot be freed from appreciable amounts of lead and iron. For a great many purposes, zinc of the purity obtainable from the distillation process has proved perfectly satisfactory and will, no doubt, long continue to do so. The process has the advantage, as compared with others, in which still higher purity is attainable, of yielding a much cheaper product, and this cheapness, particularly in the case of zinc, is very important.

Freedom from lead in the zinc employed may also be of considerable importance in the case of certain aluminium alloys, for instance, the alloy of zinc and aluminium containing about 78 per cent. of zinc has the remarkable property of undergoing spontaneous heating and temporary hardening after it has been quenched from a temperature of 380 deg. C. When the alloy is made from high-grade aluminium and pure zinc free from lead, this reaction is rapid and strongly marked. Recently an attempt was made to reproduce this phenomenon in an aluminium-zinc alloy made with a cheaper grade of zinc in which lead was present, and although the reaction still occurred to a feeble extent, the whole character and magnitude of the phenomenon was altered. So much so was this the case that it is probably right to say that if zinc, free from lead, had not been used in the original investigations on these alloys, the whole phenomenon would not have been discovered. This in itself merely goes to emphasise the well-known principle that in the scientific investigation of alloys it is necessary to secure materials of the highest possible degree of purity.

While modern commercial electrolytic zinc is a product of high purity, it is by no means a pure metal in the scientific sense of the word. Quite recently, the New Jersey Zinc Company of Pennsylvania, America, has devoted attention to the production of very pure zinc. They have prepared two varieties, the first, which they describe as "chemically pure" zinc, in fairly considerable quantities, and the second, which they describe as "spectroscopically pure" zinc, only in minute amounts in the laboratory. The chemically pure grade is stated to contain 99.987 per cent. of zinc, but when examined spectroscopically is found to show traces of lead, cadmium and iron. The spectroscopically pure metal is prepared in very small amounts in the laboratory by repeated distillation at low temperature and under a high vacuum, starting with the chemically pure metal and rejecting the first and last portions of each distillate. This fractional distillation is repeated until the arc spectrum shows the absence of impurity lines. It is believed that this metal cannot contain much more than 0.0001 per cent. of impurities.

It is, however, stated that these materials differ widely from the best commercial zinc in various properties. The most notable feature is their resistance to solution in acid. As is well known, a piece of ordinary pure zinc when wrapped in a platinum wire and suspended in dilute hydrochloric acid dissolves away rapidly, with violent evolution of hydrogen. The chemically pure variety of zinc, treated in this way, takes a period of a week to undergo solution, while the spectroscopically pure variety is said to dissolve at a rate approximately one thousand times slower.

Production of Pure Tin.

In the case of tin, a variety of the metal has recently been produced industrially which represents a considerable advance in regard to purity upon the best varieties of tin formerly commercially obtainable. A careful analysis, carried out by special means, has recently been published, and shows that this metal contains total impurities amounting only to 0.0082 per cent. The greater part of these are due to lead 0.0025 per cent., and antimony 0.0031 per cent. In comparison with this, it may be said that in ordinary standard varieties of tin the impurities vary from 0.094 per cent. to as much as 0.34 per cent. Actually, it is not only the total amount of impurities, but their variability in amount, and in the proportion of the different constituents which is disadvantageous to the user of the metal. The properties of this high purity tin, although they do not depart so strikingly from those of tin, yet show a marked difference. Both the lustre and the softness and ductility of the metal are much improved, and there is also a decided increase in the high resistance to chemical action which tin offers. Perhaps the main advantage to be derived from this high-purity material lies in the constancy of results which can be obtained when it is used in the production of alloys.

Aluminium too Expensive for Maximum Application.

For a long time after the discovery of aluminium, it was regarded as a laboratory curiosity, and its price was an impractically high figure. Modern improvement in the methods of production by fusion electrolysis from a molten bath of cryolite in which alumina is dissolved, resulted in its production at a remarkably cheap rate. The price is still, however, high when compared with that of iron and steel, and in spite of all that has been done to develop alloys of aluminium of very high strength, the price will still have to be reduced to something like one-half or one-third of its present value before the best of the aluminium alloys can compete, strength for strength, on equal terms with steel in regard to cost. In spite of this circumstance, however, there is a great development in the industrial uses of aluminium and its alloys in connection with aircraft construction and in high-power internal combustion engines. Until recently it was not possible to purify or refine aluminium once it had been reduced electrolytically from its ore. Within the last few years, however, Edwards and his collaborators, in America, have perfected an electrolytic refining process, in which molten aluminium forms both the anode and the cathode of the cell, passing by electrolysis through the fused electrolyte from the impure anodic metal to the highly purified cathode. The result is the production of an aluminium of much higher purity than anything that has hitherto been obtained. Samples of aluminium refined by the new American process, on the other hand, contain over 99.95 per cent. of aluminium. This high-purity metal again presents marked differences in properties and behaviour from the less pure variety. This is particularly noticeable in regard to the high ductility of the pure metal. While, for the moment, the extremely pure refined aluminium cannot be obtained in large quantities, and does not constitute a commercial rival to the ordinary high-grade aluminium as manufactured direct from the reduction furnaces, it seems probable that in the future the demand for increasing purity will make itself felt in regard to aluminium, as in other metals.

The Future.

It is always difficult, and often dangerous, to venture upon prediction, and especially so when the advancements of science are concerned. It must, however, be remembered that metallurgical industry and practice has had over a thousand years' start of scientific investigation of metals and alloys, so that it is not surprising to find that the deeper knowledge of metals, acquired by scientific research, is only gradually furnishing explanations of the multifarious phenomena which are met with in metallurgical and engineering practice, and that this new knowledge is only gradually furnishing complete and reliable guidance to our metallurgical manipulation. Whatever direction that guidance may take in the future as the result of further knowledge, it is quite certain that the accurate control of our materials will be carried to a greater extent than it is to-day. Materials which to-day are regarded as laboratory curiosities or industrial products, and new industrial materials, and particularly new alloys, are likely to be produced. Still more, our knowledge of the effect of mechanical and thermal treatment of metals and alloys is rapidly increasing. Forty or fifty years ago the application of heat treatment, even in the case of steel, was still exceptional. To-day, it is still to some extent exceptional in the non-ferrous alloys. In the near future it is likely to become an important factor in the industrial manipulation of alloys. Those, therefore, who produce metals from their ores are likely to find in the future an increasing stringency in the requirements of those who purchase metals from them. But there need be no fear of the stringency of those demands creating insuperable difficulties, either technical or commercial. The advance of metallurgical science, and, parallel with it, of other branches of science and technology, is likely to provide not merely higher or more correct standards of quality in regard to materials, but also better means for their production and treatment: so that, on the whole, the ancient industries are likely to benefit rather than to lose by future progress. The requirements of the engineer continue to grow more and more exacting. The producer of finished metals and alloys must inevitably meet those demands, and he in turn is, therefore, compelled to make further demands upon the producers of metals which he uses as raw material. The producer of those metals himself, on the other hand, can call upon greater resources from the engineer, the chemist, the geologist, and the metallurgist to help him to produce what modern industry requires. Progress, therefore, lies essentially in the co-operation of all those concerned with metals, whether as users of the finished product, as manufacturers of the metal, or as producers of the metal from its ore, or as scientific investigators. This close collaboration, the recognition of the unity of aim between all these branches of science and technology, is likely to be the keynote of future progress.

The Influence of Casting Temperature and Annealing on the Size and form of the Phosphide Eutectic.

According to the diagram for $Fe\text{-}Fe_3C\text{—}Fe_3P$ elaborated by Wüst it is impossible for an iron of 2.5 to 3.3 per cent. carbon and 0.4 to 0.6 per cent. phosphorus to contain any free phosphide eutectic. But it is well known that it does occur in an iron of such composition. This is caused by the crystal segregation, and, therefore, casting temperature and annealing must influence its form and size. H. Jungbluth and H. Gummert (Kruppsche Monatshefte, March, 1926) made experiments in this direction with several kinds of iron, the composition of which is recorded in Table I. The small ingots had the form of a wedge, and were poured at two different temperatures (low and high). The samples for the micrographic examination were taken always from the same area of the wedges and etched with picric acid. The areas of the phosphide eutectic were measured under the microscope. The values are recorded in Table II, column II, in percentages of the total area inspected. It is to be seen that there is a less amount of eutectic in the samples poured at the higher temperature. This is due to the slower cooling rate, which enables the phosphorus to diffuse into the iron in a higher degree than in the samples poured at the lower temperature. The lower strength of the hot-poured samples can be attributed to the fact that the phosphide eutectic forms a network which weakens the coherence of the metal. Column III, Table II, shows that the casting temperature practically has no influence on the grain size of the eutectic. In order to examine the influence of annealing, the wedges were cut into pieces and packed in drillings, heated for two hours at the following temperatures: 500, 600, 700, 830 and 900 deg. C. After the annealing the areas of the eutectic were measured again. The results are recorded in Table III. It is to be seen that the eutectic does not begin to coagulate until 830 deg. C. Therefore it can be assumed that the diffusion of the phosphorus cannot take place in a perceptible degree but after the carbide had decomposed to a certain extent. The micrographic examination revealed that there remained pearlitic islands around the phosphide eutectic, a fact which cannot be interpreted.

TABLE I.

Sample No.	C. per cent.	Si. per cent.	Mn. per cent.	P. per cent.	S. per cent.
1	3.31	1.13	0.70	0.47	0.11
2	3.20	1.75	0.73	0.54	0.13
3	3.30	1.97	0.69	0.64	0.13
4	3.05	1.50	0.98	0.62	0.14
5	3.20	2.06	1.09	0.47	0.14
6	2.56	1.10	0.57	0.44	0.16
7	2.56	1.55	0.80	0.39	0.073
8	2.32	1.93	0.80	0.35	0.086

TABLE II.

Sample No.	Phosphide Eutectic in percentages of total area.		Grain size.	
	Per cent.	Average value.	μ^2	Average value.
1 K	3.1	—	400	—
1 H	3.5	—	510	—
2 K	3.2	H = 2.82	440	H = 538
2 H	2.4	K = 4.06	450	K = 574
3 K	3.1	—	360	—
3 H	1.4	—	260	—
4 K	7.0	—	950	—
4 H	5.3	—	1,230	—
5 K	3.9	—	540	—
5 H	1.3	—	420	—
6 K	4.5	—	1,200	—
6 H	2.6	H = 2.5	720	H = 767
7 K	2.8	K = 3.2	610	K = 630
7 H	2.4	—	630	—
8 K	2.4	—	490	—
8 H	2.5	—	540	—

K = low casting temperature.
H = high casting temperature.
μ = 0.001 mm.

TABLE III.

Sample No.	Annealing temperature °C.	Phosphide eutectic in percentages of total area per cent.
5 H	600	4.34
5 H	700	4.34
5 H	830	2.47
5 H	900	2.3
6 H	600	4.0
6 H	700	4.05
6 H	830	3.7
6 H	900	1.6
7 H	600	3.41
7 H	700	4.0
7 H	830	1.92
7 H	900	1.92
8 H	600	2.72
8 H	700	2.67
8 H	830	2.35
8 H	900	2.2

Treatment of Steel with Ferro-Carbon-Titanium.*

By G. F. Comstock (Niagara Falls, N.Y.).

The object of this Paper is to show actually what is being done with ferro-carbon-titanium at the present time, giving an outline of the practical results that are being obtained by its use. The ferro alloy as used in steel manufacture contains about 17 per cent. titanium and 7.5 per cent. carbon. Pound for pound, it has less deoxidising capacity than the common 50 per cent. ferro-silicon, but, in view of the stronger affinity of titanium for oxygen, its use as a final addition, after the silicon and other deoxidisers, results in making the degree of deoxidation of steel more complete.

Ferro-carbon-titanium is essentially a grey cast iron containing titanium-carbide, as well as some dissolved titanium. It is made in an electric-arc furnace by reduction of the oxide ore with carbon. A few other types of titanium alloy have a limited practical use, one of the most prominent of them being the alumino-thermic alloy containing about 25 per cent. titanium, partly in the form of nitride, and a considerable amount of aluminium.

The use of ferro-carbon-titanium as a deoxidiser in the ladle has been found convenient and advantageous at a number of large plants, making good-quality effervescing steel for plates and sheet-bar. The amount used generally varies from 1 to 4 lbs. of alloy per ton of steel, and depends on the general practice or on the melter's judgment of each individual heat. The advantage of this alloy over aluminium is that it does not make the steel dirty. Steel treated with aluminium can invariably be distinguished by its dirtiness, due to alumina inclusions. On the other hand, aluminium has the advantage that it can be used in the mould, after the action of the steel in the first mould poured has been observed, while ferro-carbon-titanium must be used in the ladle on account of its slower rate of solution and its carbon content. If insufficient titanium has been added in the ladle, an additional deoxidation can be obtained by using a little aluminium in the moulds.

The use of "silicon pig" in the furnace before tapping is seldom considered a substitute for titanium treatment, but may be practised with the latter. It is not safe to rely entirely upon this method for preventing over-oxidation, because the proper end-point of the reaction is not well-enough marked. The steel is too often too much deoxidised in this way, and the effervescence hindered, unless, as is usually done, the whole effect of the silicon addition is allowed to disappear before tapping. Then the use of titanium in the ladle is advantageous to correct oxidation that may occur after the silicon has all been "worked out." It is sometimes claimed that the use of silicon pig in the furnace "cleans" the steel, but in the tests known to the author where this point has been carefully investigated no effect of this kind was found.

Another advantage from the use of titanium in steel, whether effervescing or not, comes from the fluxing action of its oxide on the furnace slag which may become mixed in the steel. Doubtless the fact that titanium oxide inclusions are not found in titanium-treated steel, as are alumina and silicates in steels treated with aluminium and silicon respectively, is due to this fluxing character of TiO_2.

In the application of titanium to killed steel the conditions are entirely different, and a complete absence of gas evolution as well as the maximum degree of deoxidation are generally desired. Besides manganese, silicon is always used in this kind of steel, generally in the ladle, and in addition aluminium or titanium may also be used in the ladle, or occasionally steel is killed with aluminium in the moulds. This last practice, however, makes very dirty steel, and should be discouraged. The amounts of the various deoxidisers used in killed steel differ so greatly, according to the kind of steel made and the general practice followed, that it is impossible in a paper of this scope to give more than a few general observations. The following paragraphs refer to steel cast into ingots for rolling; steel for sand castings will be discussed separately later on.

* A Paper read before the Stockholm Meeting of the Iron and Steel Institute.

Ingot Steel.

For steel of low or medium carbon content which is to be killed in the ladle, the usual practice is to use from 5 to 8 lbs. of 50 per cent. ferro-silicon per ton, to give a silicon content of about 0.08 to 0.15 per cent. Under certain conditions, when complete deoxidation is not essential, and a silicon content is to be avoided, about 1 lb. per ton of aluminium may be used in the ladle instead. Ferro-carbon-titanium may be substituted for part of either the silicon or aluminium additions, although its use with aluminium is not generally recommended, because its fluxing action on alumina is not very effective. One pound of aluminium may be considered roughly as the equivalent in deoxidising capacity of about 4 lbs. of 50 per cent. ferro-silicon, or 6 lbs. of ferro-carbon-titanium. This does not mean that titanium is not a stronger deoxidiser than silicon, but merely that it is added in the form of a more dilute alloy. On account of the titanium alloy being of only 17 per cent. strength, it is not practicable to kill a heat of steel with titanium only. It is nearly always used with silicon, in proportions varying from one-half to twice as much as the silicon addition. When used thus it is generally the last addition to the ladle, and tends to clean up the last traces of oxide; or, in other words, to extend the degree of deoxidation somewhat further than can be attained with silicon alone. In high-carbon steels, as made for rails, titanium is often used in larger quantity, up to 13 lbs. per ton, with a slight decrease in the usual silicon content. This treatment of rail steel has been found to be very effective in controlling segregation in the upper part of the ingot, while merely increasing the usual silicon content has not turned out to be a great success in that direction.

The strong deoxidising power of titanium is described by Dr. Jordan, of the Bureau of Standards, who shows that the oxygen content of rail steel decreases from 0.0048 per cent. to nothing as the addition of ferro-carbon-titanium is increased from zero to 10 or 12 lbs. per ton.

In killed-steel ingots in general, titanium is used to decrease segregation by securing more perfect deoxidation, and, as has been already noted, this result is accomplished without contamination of the steel by any oxidised product analogous to silica or alumina. Finer sulphide inclusions and a less streaky microstructure are also characteristic of titanium-treated killed steel. These effects have been discovered by extensive tests involving the examination of many specimens, and, as an example, a brief account of a recent test of this kind is given as follows:—

Twelve heats of basic open-hearth steel were made at a large steel plant, the compositions ranging between the following limits, as shown by the ladle-test analyses:—Carbon, 0.09 to 0.12 per cent.; manganese, 0.28 to 0.43 per cent.; phosphorus, 0.010 to 0.013 per cent.; sulphur, 0.020 to 0.038 per cent. The furnaces were charged with about 120 tons of metal, approximately half of which was pig-iron. Different methods of treatment or deoxidation were used, as summarised below, and one or more ingots from about the middle of each heat were chosen for special study. The following kinds of steel were made:—

(1) Four heats of titanium-treated effervescing steel, each represented by one ingot.

(2) Four heats of effervescing steel without titanium, each represented by one ingot.

(3) Four ingots of steel, one from each of the above heats, killed in the mould with silicon.

(4) Four ingots of steel, one from each of the same heats, killed in the mould with aluminium.

(5) Two heats of killed steel treated with silicon only, each represented by one ingot.

(6) Two heats of killed steel, treated with titanium and silicon, one represented by two ingots, and the other by one.

No ore was added to these heats less than one hour before tapping except in one instance (untreated, effervescing), and it was interesting to note that the only special ingot that appeared "thin-skinned" at the blooming mill was from this heat. The slag on each heat was treated with 500 lbs. of burnt lime about 15 to 40 minutes before tapping, and from three to seven minutes before tapping about 1,400 lbs. of ferro-manganese was added to each heat. From about thirty minutes to an hour before tapping each of the killed heats was treated with 1,000 lbs. of 15 per cent. silicon pig, and the effect of this addition was allowed to wear off so that the steel boiled freely again. Each class of four effervescing heats was divided into two pairs, one pair being treated with silicon pig in the furnace, and the other pair not so treated. The amount of silicon pig used in the two effervescing titanium-treated heats was 250 lbs. apiece, while in the two effervescing heats without titanium that were treated with silicon pig, 500 lbs. of the latter was used in each.

After tapping, the four untreated effervescing heats received from 20 to 30 lbs. of aluminium in the ladle; and the four treated effervescing heats received additions of 250 lbs. of ferro-carbon-titanium, amounting to from 2.2 to 2.5 lbs. per net ton (2,000 lbs.) of steel in the ladle. The killed heats received ladle additions as in Table I.

TABLE I.

Heat.	J.	K.	L.	M.
80 per cent. Fe-Mn. (lbs.)	25.0	nil	nil	nil
50 per cent. Fe-Si. (lbs.)	550.0	550.0	500.0	500.0
,, ,, (lbs. per net ton)	5.3	5.1	4.75	4.4
17 per cent. F.C.T. (lbs.)	nil	nil	400.0	400.0
,, ,, (lbs. per net ton)	nil	nil	3.75	3.35
Total silicon (lbs. per net ton)	2.65	2.55	2.46	2.28
Total titanium (,, ,,)	nil	nil	0.64	0.57

The ferro-carbon-titanium was the last addition to the steel in the ladle when it was used, and the ladle additions were all completed before the slag started to flow from the furnace. The first mould was generally teemed from nine to thirteen minutes after tapping, and the 3-ton 20-in. × 22-in. special ingots were poured usually in about 55 or 60 seconds. The titanium-treated effervescing steel ingots sank considerably in the moulds before rimming, but the other effervescing steels which had received a little aluminium in the ladle did not fall or rise very much. 4 lbs. of aluminium, or 11 lbs. of powdered ferro-silicon in the moulds, was found sufficient to kill the ingots. The heats treated with silicon in the ladle were not completely killed, and the tops of these ingots bulged considerably except in the case of heat J.

The special ingots were rolled at one heating down to 1½-in. square billets, and no particular difference was noticed in the rolling character of the different classes of steel, except that perhaps the killed ingots were a little better. An accurate record of the top and bottom discards taken at the mill was kept, and considerable variation, from about 4 to 13 per cent., in individual top discards was noted. There was no consistent difference in this respect, however, between the various kinds of steel. The steel was not followed through the mill beyond the billet stage, and in this test no data on yield or quality of finished product were secured.

Samples for laboratory investigation were obtained from the top, middle, and bottom of each special ingot, in the form of 6-in. lengths of the 1½-in. square billets. Sulphur prints were made only from the top samples of ingots from the killed heats, for previous experience indicated that samples from the lower parts of the ingots would not show anything of interest when tested in this way, and the effervescing steel ingots would, of course, all show segregation at the top. The sulphur prints showed a more uniform distribution of sulphur, in general, in the titanium-treated steel than in the steel treated only with silicon. The discards were sufficiently similar, so that it is not probable that the slight variations had any appreciable effect on the types of sulphur print obtained.

Specimens about ⅝-in. square were cut lengthwise from near the centre of the section of each billet sample for microscopic examination. After careful polishing each specimen was examined at a magnification of about 180 diameters, and classified in regard to the distribution of the sulphide inclusions, and to the general cleanness or amount of slag and alumina present. The results of this classification were checked by two observers, and afterward the specimens were etched with nitric acid. Another classification was then made, noting the amount of pearlite present, the general grain-size, and the quality of the structure in regard to streakiness.

To facilitate the comparison of the different kinds of steel the notes on cleanness and structure were summarised in the following manner. A grade of "bad" was given the number "0"; a grade of "poor," 1; "fair" was called 2; and "good," 3. These numbers were then averaged for each class of steel, and the results give a comparative measure of the quality of the different classes in regard to the characteristic under consideration. The notes on sulphide distribution are very similar to those on structure, so that the comparisons on the basis of these two characteristics may be considered as practically the same. A higher number for the average, as given in Table II, means of course a cleaner steel, or a more uniform structure.

TABLE II.

	Average grade in regard to—	
	Cleanness.	Structure.
Effervescing steel without titanium:	1.00	1.92
With silicon pig in the furnace ..	0.67	2.33
Without silicon pig in the furnace ..	1.33	1.50
Titanium-treated effervescing steel:	2.17	1.50
With silicon pig in the furnace ..	2.17	1.67
Without silicon pig in the furnace ..	2.17	1.33
Heats killed with silicon in the ladle ..	1.08	2.13
Heats killed with silicon and titanium in the ladle	1.11	2.77
Steel killed with silicon in the mould ..	0.33	2.17
Steel killed with aluminium in the mould	0.33	0.332

The titanium-treated effervescing steel was the cleanest of any of these steels, and there was a marked difference in cleanness between it and all the other kinds. The titanium-treated killed steel showed the most uniform structure, as was also indicated by the sulphur prints, but showed only a very slight improvement in cleanness over the other steel killed with silicon in the ladle. The inclusions in the titanium-treated steels were similar to normal silicates, except that they were more apt to show a duplex structure, with a lighter angular constituent embedded in the darker slag. The ingots killed with silicon or aluminium in the mould were very dirty, but showed quite uniform structures. Those treated with aluminium could be very easily identified by the typical alumina inclusions that they contained, in some cases in very large amounts.

The use of silicon pig in the furnace resulted in no improvement in cleanness in the effervescing steels, the only class in which this comparison was made. The two effervescing heats without titanium that were treated with silicon pig in the furnace showed less pearlite than any of the other heats; this was especially true of one heat, which contained hardly any pearlite at all. Of course, where very little pearlite is present, streakiness of structure cannot be very marked, and the high grade of the effervescing steel without titanium, with silicon pig in the furnace, in regard to structure is accounted for in this way, and is probably not directly due to the effect of the silicon pig.

Removal of Nitrogen.

Returning to the discussion of the action of titanium on steel in general, it has been asserted

that titanium combines with nitrogen and tends to remove it from the steel. This assertion is undoubtedly justified, and is supported by the fact that distinctive pink crystals of titanium nitride or cyano-nitride are often found in high-carbon steels treated with comparatively large amounts of titanium, and some results of nitrogen determinations made on samples of rail steel from different heats and various mills by the modified Allen method are given in Table III:—

TABLE III.—*Nitrogen Content of Rail Steel.*

No. of samples.	Titanium-treated. 28	Ordinary steel. 25
	Per cent.	Per cent.
Maximum	0.0062	0.0100
Minimum	0.0015	0.0032
Average	0.0036	0.0051

The titanium-treated steel in these heats was treated with 10 to 13 lbs. of ferro-carbon-titanium per ton. In soft steels treated with less titanium no decreased nitrogen content as compared with untreated steel has been found by analyses. The practical value of the decrease in nitrogen content by titanium treatment as noted above for rail steel is questionable, for the reason that the harmfulness of even more than 0.01 per cent. nitrogen in steel has not been definitely established.

Steel Castings.

The use of titanium in steel for sand-castings remains to be considered. This kind of steel must be very thoroughly deoxidised, and is usually made with silicon around 0.3 per cent. Very often aluminium is also used to complete the deoxidation and overcome the last slight traces of unsoundness, but this practice generally results in impaired physical properties on account of the presence of alumina inclusions and streaks of fine sulphides. The aluminium in cast steel causes the sulphides to be finer than usual, and arranged in a network of curved lines which results in early cracking under tensile stress, so that good ductility is not shown. By the use of titanium in place of aluminium as the final deoxidiser, many steel foundries avoid this trouble and secure better ductility in their castings. Titanium treatment of cast steel has also been found practically always to give a better elastic ratio, probably on account of cleaner steel, and a more feathery microstructure as cast, so that grain-refinement by annealing is more easily accomplished and more complete.

In conclusion, it is desired to emphasise the fact that ferro-carbon titanium is not claimed to be anything wonderful or mysterious. Its value lies in its being a good deoxidiser, more powerful qualitatively than silicon, and one that does not make steel dirty when it is used. In effervescing steel it corrects over-oxidation conveniently, maintaining the cleanness of the metal and not hindering the effervescence. In killed steel it gives more complete deoxidation, without dirtiness, and prevents serious segregation. Like every other alloy, it must be used properly to give good results, and it must not be expected to cure defects which no deoxidiser could overcome.

Influence of Blast Temperature on Pig-Iron.

Two kinds of iron can wholly differ in their mechanical properties in spite of being of the same composition. According to the investigations of Piwowarsky it is the highest temperature to which the pig-iron is exposed in producing it or afterwards which has the greatest influence on the graphite or carbide formation and therefore on the mechanical properties. One might suppose, therefore, that it is the different temperatures in the blast furnace which are responsible for the divergent qualities of two kinds of pig. A. Wagner ("Stahl und Eisen," 1926, No. 30, p. 1005-12, July 29) made experiments in order to determine in what degree the preheating temperature of the blast had an influence in this direction. One of two blast furnaces was worked with blast of 550 deg. C., the other with blast of 850 to 950 deg. C. The pig-iron of six charges of each of the two furnaces was examined in regard to composition, tensile strength, hardness, transverse strength. The average test values are recorded in the Table I. It is to be seen that a fundamental difference of the two pigs does not exist, a fact which was also revealed by the micrographic examination. The fluctuation of the composition, especially of the graphite content in percentages of the total carbon content of pig II is not caused by the difference of the blast temperature, but by the large fall of temperature during one blast period.

TABLE I.—*Influence of Blast Temperature.*

Furnace No.	Charge No.	Si. Per cent.	S. Per cent.	Mn. Per cent.	P. Per cent.	Total carbon. Per cent.	G. in percentages of the T. C.	Tensile strength. t/sq. in.	Transverse strength. t/sq. in.	Brinell hardness number.
I. (550°)	1	1.75	0.011	0.091	0.0526	4.31	73.7	5.37	11.04	157
	2	1.55	0.011	0.092	0.0549	4.19	77.2	5.15	11.04	146
	3	0.93	0.053	0.081	0.068	4.12	70.3	7.81	14.6	183
	4	1.67	0.015	0.09	0.075	4.19	73.1	7.3	14.92	181
	5	1.04	0.055	0.08	0.072	3.96	72.6	7.3	15.96	187
	6	1.13	0.054	0.10	0.062	4.02	74.3	7.55	17.07	184
II. (850° to 950°)	1	2.18	0.012	0.085	0.062	4.15	73.6	7.23	14.06	169
	2	1.96	0.015	0.080	0.066	4.30	75.6	6.73	14.12	164
	3	1.25	0.024	0.072	0.068	3.99	69.6	7.17	15.17	170
	4	1.91	0.010	0.070	0.074	4.16	78.9	6.98	17.67	164
	5	1.18	0.029	0.062	0.061	3.97	69.3	6.73	16.15	178
	6	1.06	0.038	0.052	0.061	4.09	67.6	5.23	12.44	150

The results of the experiments in question seem to be contradictory to Piwowarsky's results. Wagner, however, is of opinion that besides the heat which is supplied by the gases and which he calls "dry heat," the heat content of the slag ("liquid heat") takes a prominent part in controlling the temperature of the pig-iron. This opinion is supported by many examples in practice. All the plants where the blast furnaces are worked with a large amount of slag (Buverus works: 120 per cent., Cleveland works 170 per cent.) produce an excellent soft foundry pig-iron. Of course, the period during which the pig is exposed to the action of the slag, that is, the period of the working of the charge, will also be of influence. Experiments in this direction are to be made. Moreover, the fusibility of the slag is important, as an easily fusible slag can act on the iron already in the upper parts of the shaft. A Rhineland blast-furnace plant, for instance, has greatly improved the quality of the pig-iron by charging lump slag low in sulphur. In the case that the pig is not sufficiently acted upon by the "liquid heat" in the blast furnace, it can be improved afterwards by the action of the "dry heat" in the mixer and the reverberatory furnace; it is especially in the latter that the iron can be superheated in a very high degree. The electric furnace is inferior to the reverberatory furnace because of the less amount of slag and the high expenses in the case of a prolonged "dry heat" treatment. The cupola comes last, as the iron cannot be sufficiently superheated during the short period of the working of the charge. Experiments are to be made in what degree this failure can be removed by a large amount of slag and what composition of the slag is the best.

XUM

Foundry Workers and Piece-Work.

Deductions and Notices under Truck Act.

BY A BARRISTER-AT-LAW.

An Iron Foundry Case.

A matter of considerable importance to iron founders and the trade generally came recently before the King's Bench Division on a case stated by local justices. The appellant in the case who was a moulder, had preferred an information before the local magistrates against the respondents, who were iron founders. The proceedings were taken by the appellant under the Truck Act, 1896, on the ground that his employers on two different dates had unlawfully made specific deductions from his wages. It appeared that the respondents, who were engaged, among other work, in making iron pipes, had employed the appellant on piece-work only as a moulder of the pipes, and that they had undertaken to pay an agreed price of 5¾d. per complete pipe of 6 ft. in length, free from defects. If a pipe was delivered incomplete or defective, the moulder was still to be paid an agreed price, which was fixed at the time of his employment as a piece-worker. Should it become necessary through any defect to cut off a portion of a pipe, payment was then to be made for the remaining length. If, for instance, 2 ft. were cut off, the moulder was to be paid 4¾d., which was the agreed price so fixed for a 4-ft. pipe. Should a bent pipe have to be straightened, then the price agreed was to be 5¼d.; and if a pipe were so rough that it had to be ground, 5¼d. was also to be the price to be paid. In case holes had not been properly cored, or if holes had to be drilled by the respondents, 5½d. or 5 7/12d. became the respective rates of payment when delivered.

Requirements under the Act.

Under section 2, sub-section 1, of the Act, an employer is prohibited from making any contract with any workman for any deduction from the sum contracted to be paid by the employer to the workman, or for any payment to the employer by the workman for or in respect of bad or negligent work, or injury to the materials or other property of the employer, unless certain conditions are observed. These may be briefly summarised as follows:—

(a) The terms of the contract must be contained in a notice kept constantly affixed where it can be easily seen by any person affected; or the contract must be in writing, signed by the workman; and

(b) The said deduction or payment must not exceed the actual or estimated damage or loss occasioned to the employer by the act or omission of the workman, or of some person controlled by him, or for whom he has agreed to be responsible; and

(c) The amount of such deduction or payment must be fair and reasonable. Sub-section 2 of the same section provides that no employer shall make any deduction or receive any such payment, unless:—

(a) It is in pursuance of, or in accordance with, such contract; and

(b) Particulars in writing of the acts or omissions in respect of which the deduction or payment is made and the amount thereof are supplied to the workman when the deduction or payment is made. It is an offence under section 4 for any employer to enter into any contract or to make any deduction, or receive any payment contrary to the Act.

Contentions in the Case.

The appellant, by reason of the variations in payment previously mentioned, had been apparently twice paid by the repondents, wages that were respectively less than certain amounts which he would have received for the same number of pipes had they been complete and free from defects. It also appeared that no notices required by the Act as to the terms of the agreement were kept by the respondents, and that they had not supplied the appellant with any particulars in writing under the Act. It further seemed that it was not possible for the appellant to determine accurately, in the state in which the pipes left his hands, whether they were complete and free from defects, or whether, and to what extent, they were incomplete or defective. The condition of the pipes, after delivery, was apparently checked by persons appointed by the respondents for that purpose, in conjunction with other persons appointed by the general body of the respondents' workmen for the purpose. While the appellant contended before the local bench that the agreement between the parties was one for deductions from the sums contracted contrary to the Act, and that the two deductions were made also contrary to the Act, the respondents contended that the Act did not apply to the system of wages in force at their works, and that they, in fact, had made no deductions from the agreed remuneration. The information was dismissed by the local justices, and a case stated as mentioned.

Deduction of a Bonus.

It is true that, in a case tried in 1906, where a bonus was given to employees for full attendance and withheld if they were absent for any time, it was decided that the deduction of the bonus from the wages of an employee who was absent for a quarter of a day was not an offence against the Truck Act, but this case will be easily distinguished from the present one. Nor does it seem possible to keep outside the Act simply by terming what is in essence a deduction for negligent work a variation of the rate of remuneration. This is none the less so, notwithstanding the fact that the relevant section is a penal section, and, therefore, has to be strictly construed.

Application of Act to Piece-Work.

The Truck Act, 1896, applies, without doubt, to piece-work, and this statement of the law was expressly confirmed by one of the three learned judges in the present case. By section 10 of the Employers and Workmen Act, 1875, applied by the Truck Amendment Act, 1887, with which (amongst others) the Truck Act, 1896, is to be read as one, the expression "workman," although it does not include a menial or domestic servant, includes all other persons engaged in manual labour for an employer, whether they are under contracts of service or under contracts for the personal execution of work.

Judgment in the Case.

In allowing the appeal, the Lord Chief Justice thought it was clear that the contract in the present case was that the appellant should produce a complete pipe 6 ft. long and free from defects, for which he was to be paid 5¾d.; that was the standard or normal pipe, and that was the basis of the contract of employment. His Lordship also stated that the series of variations of the sum of 5¾d. depended upon whether the pipe was of the right length, whether it was straight or bent, or was too short or too rough, or whether the holes in it had been properly cored; the variations depended upon the performance of the appellant in producing his work. The learned judge could scarcely imagine a more exact repetition of what is struck at by section 2 of the Act—a deduction "for or in respect of bad or negligent work, or injury to the materials or other property of the employer."

Necessity of Careful Attention.

The result of the case shows the necessity of all employers giving careful attention to the Act, whether their employees are engaged on the works or are employed as out-workers, so that the legal requirements may be duly complied with, especially in the steps requisite to protect themselves whenever any deduction or payment is made part of the bargain with their workmen.

Area Covered by Cast-Iron Scrap.—It is useful to know, when stock-taking, that closely-packed cast-iron scrap will weigh one ton for about every 14 cubic feet of area covered. If loosely packed, it will weigh approximately one ton for every 17 cubic feet of area covered. As a comparison, pig-iron, evenly stacked, will cover 8 cub. feet per ton.

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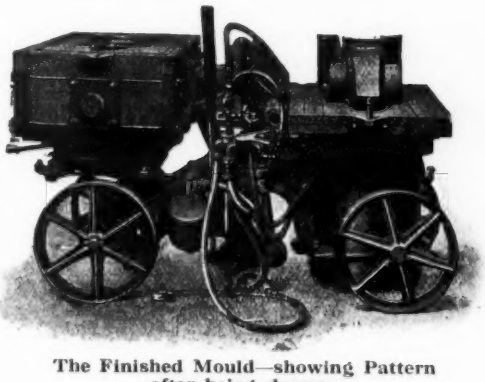

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Sand jar rammed by "Shockless" device—Tabor Patent—without shock to the machine or surrounding moulds.

***Machine not restricted to use of one size moulding box—any size can be used up to load capacity of machine.**

Good surface castings.

Pattern plates can be changed instantly without unfastening mechanism so that comparatively small quantities can be made economically.

Perfectly straight draw ensured by mechanical guides of large surface to prevent wear and retain accuracy.

All moulds jar rammed in a few seconds and thoroughly uniform in density, ensuring minimum quantity of defective castings and less blow holes.

All operations other than sand filling are completed in two minutes for any size of work within capacity of machine. To realise what this means, compare your present wage cost for the same work!

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Testing Cast Iron.

Prof. C. H. Bulleid, of University College, Nottingham, described some work which he has done in regard to the testing of cast iron. He pointed out that a great deal of work has been done on the fatigue of steel and various other metals, but very little information is available about the fatigue of cast iron, and his object was to supply information on this point. It is recognised, he said, that cast iron is an alloy of very varied composition, and the conclusions come to as the result of his work should not be applied too widely, or to irons differing greatly from the one he has tested. Preliminary experiments showed that the results would be somewhat irregular, and that it would be necessary to test a considerable number of specimens to eliminate casual variations. In order to enable such tests to be carried out in a reasonable time a special type of Wohler reversed bending machine was designed.

This machine consists of a box casting through which pass the spindles, each carrying a collett chuck at each end. Inside the casting these spindles carry gear wheels keyed to them, and idle wheels running on short axles between the spindles transmit the motion from one to another. The main driving pulley is keyed to a shaft wheel, gearing into one of the idle wheels. At the back of the machine three 100-1 worm wheel reductions cause a drum to revolve at one-millionth the speed of the driving pulley. The drum is 4 in. diameter, and as there is a 3-4 ratio between the driving pulley and the specimens, 1 in. on the drum corresponds to 106,060 revolutions of the specimen. The machine was made self-recording, and the necessity for stopping when a specimen broke was obviated by attaching a string to the end of each specimen, passing it through a ring above the drum, and leading it down to a weighted pencil, the point of which bore on a paper attached to the drum. When a specimen broke its pencil was thus withdrawn and the recorded line ended, its length indicating the number of revolutions needed to cause fracture. The machine continued to run and the other pencils to record until their respective specimens broke. The speed of revolution was 1,000 per minute, and the machine ran from 9 a.m. to 9 p.m. daily, except Saturdays, thus a specimen could be run to infinity (10 million revs.) in about 2½ weeks. At the outer end of the specimen a Skefko self-aligning ball bearing was placed, and from the housing of this the load was hung, thus eliminating any uncertainty as to the point of application of the load. To eliminate any inertia stresses due to eccentricity or vibration, the loads were suspended from the housing by spiral springs, so that the period of oscillation of the load was very long compared with the time of revolution of the specimen.

The springs extended 1 in. for 10 lbs., and hence an extreme eccentricity such as $\frac{1}{10}$ in. would only have caused a variation of 1 lb. in the load. Owing to the manner in which the specimens are machined and held, the eccentricities were very much smaller than this. Any tendency for the weights to work up a steady, free oscillation was prevented by a strip of paper threaded through the coils of the spring. This introduced enough friction to damp out any free oscillations.

The stresses were calculated from the formula

$$\frac{B}{y} = \frac{M}{I}$$

M being found by multiplying the total load (= weights + hanger + spring + ball race and housing + ¼ specimen) by the distance from the centre of the ball race to the actual point of fracture, y and I being calculated from the actual diameter at the point of fracture.

The expression for the stress reduces to

$$\frac{220d}{WA\ 3}$$ tons per sq. inch.

W = total load in lbs.
A = length of arm in inches.
d = diameter of fracture in inches.

Of course, this formula does not give the actual stress above the elastic limit, and in particular it gives much too high a result for a fracture in bending under a dead load, which gave 22.4 tons, whereas the direct tensile test only gave 11.4 tons. This is the well-known phenomena of the beam paradox. No other simple means of calculating the stresses is possible, and no error need arise if it be remembered that the stresses given on the paper are conventional stresses calculated as thus described.

To ensure a sufficient number of specimens of the same composition thirty-six bars were cast horizontally in one box, parallel to one another. The bars were fed at one end from a long gate and connected at the other end to another gate terminating in a rise.

Each specimen was centred and turned to ½ in. diameter at one end for a sufficient length to fit the collett chuck and allow for grinding at the neck, and also for a short length at the other end to take the ball race, it was then ground at the neck so as to make the distance from the centre of the ball race to the centre of the neck 6 in. The plane of the specimen was in the plane of the grinding wheel, and the specimen was revolved comparatively slowly so that all grinding scratches were in the axial direction and so did not form starting points for fatigue cracks. The experiment was commenced by determining the load needed to cause fracture when the specimen was stationary. This was done by putting a specimen in the machine and loading it gradually by hand. It broke with a load of 45 lbs., giving a stress of 22.4 tons per sq. in. This is in excess of the tensile strength on account of the so-called beam paradox.

A difficulty arose in tests with loads near the static breaking load. It was found that if such a load was put on whilst the machine was at rest the specimen broke at once on starting up. A few points on the curve corresponding to high stress and few revolutions to fracture were therefore determined as follows:—

Specimens were put in the machine, which was started up, and they were then loaded up rapidly until they broke. The stress was calculated from the load at fracture and the revolutions by timing. This gives a figure for the reversals which is somewhat too high, as part of the test takes place under a lower load. The remainder of the points were determined by putting on a load calculated to give the desired stress, and then running the machine till fracture occurred. The actual stress was then calculated on the measured diameter at fracture and the actual length of the arm from the centre of the ball race to the fracture. Whilst the higher stresses give rather irregular results the lower stresses indicate a definite limiting stress at 9.7 tons per sq. in., also the fracture occurs practically at once for the reversal of a stress of 14.5 tons.

For so variable a material as cast iron conclusions from tests on one sample must be made with due caution. It would appear that for the material used in these tests the phenomena of fatigue when caused by the simple reversal of a bending stress is not essentially different from that in other metals such as steel.

If the transverse stress determined by dead loading be denoted by 100, fracture will occur almost at once with a load of 65, and a load of 43.5 will be endured for 10 million revolutions.

Australian Research Students.—Eight specially selected Australian graduates are to be sent abroad for training in research. Two of these will undergo a course at the British Fuel Research Station at Greenwich, two at the Low-Temperature Research Station at Cambridge, one in research in pottery and ceramics, two in forestry research, and one in plant diseases.

Empire Mining and Metallurgical Congress, 1927.—The Empire Council of Mining and Metallurgical Institutions on behalf of the ten Constituent Bodies has accepted an invitation to hold the second (triennial) Empire Mining and Metallurgical Congress in Canada in August-September, 1927. The opening session will be held in Montreal, on Monday, August 22. An influential organising committee representative of the whole of the Dominion has been constituted, and an attractive programme is now practically completed. It embraces Sessions in Montreal (inaugural), Toronto, Winnipeg, and Vancouver, with visits to mines and works and places of scenic beauty throughout the Dominion. The full programme will occupy about six weeks in Canada. The Hon. Secretary-General is Mr. C. McDermid, 225, City Road, London, E.C.1.

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Trade Talk.

THE HAYBRIDGE FORGE, Shropshire, which has been closed for some time, will, it is stated, shortly be started on modern lines by a Smethwick firm.

THE L.M. & S. Railway Company have approved the order of a further thirteen "Sentinel-Cammell" rail coaches for use on various parts of their system.

MESSRS. BROWN BAILEY'S STEEL WORKS at Sheffield are restarting a Siemens furnace on imported Continental coal. The number of unemployed in Sheffield has fallen by more than 4,400 since the end of June, works being kept going on outcrop and Continental coal.

MESSRS. WILLIAM HAMILTON & COMPANY, LIMITED, Port Glasgow, have obtained orders for two large vessels—one an oil-tank steamer for a Liverpool firm, and the other a cargo steamer for foreign owners. The company are at present building for the Brockle-Bank Line a vessel which they hope to launch by the end of this month.

THE FIRST SHIP built in the Irish Free State was launched last week from the Dublin yard of Messrs. Vickers (Ireland), Limited. She is a twin screw tug, 110 ft long by 21 ft. beam, built to the order of the Wanganui Harbour Board, New Zealand. A larger tug, also for New Zealand, is under construction in the same yard.

IT IS reported from New Zealand that the Auckland City Council had received tenders for 600 tons of steel rails, one from the agent of the United States Steel Rails Company for £6,569 and four British tenders ranging from £8,544 to £9,907. The Tramway Committee recommended the acceptance of the American tender, but the Council decided to accept a British tender if delivery could be effected before the end of the year.

WORK HAS BEEN suspended on the 20,000-ton motor liner which Messrs. Swan, Hunter & Wigham Richardson, Limited, are building at Walisend for Messrs. Shaw, Savill & Albion Company, of London. Rumours were current that the contract for the Walls-end liner had been cancelled, but inquiries at Messrs. Swan, Hunter & Wigham Richardson's do not confirm this. Whether eventually the liner will be completed is a matter of conjecture, but the present position is a serious one, having regard to the severely depressed state of the shipbuilding industry on the Tyne. The coal stoppage presumably is the root cause of this suspension of work.

A PARTY of German economic students paid a visit of inspection to the Melingriffith Tinplate Works recently, in company with Mr. Spence Thomas (managing director) and Mr. Davies (manager). Mr. Davies replied to the vote of thanks proposed by Professor Plant; Mr. Spence Thomas spoke of the imminent race for technical superiority which was about to occur between the British and Continental manufacturers. He had been greatly struck, during his recent visit to Germany, by the remarkable improvement in the German plants which had occurred since the war. To retain the British supremacy in the industry great efforts would have to be made in the next few years.

Obituary.

MR. ALFRED W. AUSTER, of Park Hill, Moseley, Birmingham, who was associated with Messrs. Auster, Limited, Crown Works, Birmingham, has died at the age of 65.

MR. RALPH SPENCER, of Netherwitton Hall near Morpeth, Northumberland, died last week at his home at the age of 66. During the whole of his business career he was associated with John Spencer & Sons, Limited, Newburn, and for fifteen years was chairman of the board of directors.

MR. HARRY PROBYN, who recently died at Edgbaston, was connected with Guest, Keen & Nettlefolds for many years. He was the first secretary of Guest, Keen & Company on the incorporation of the firm in 1900, and after the change of name to its present form two years later, he continued in the secretaryship until 1918, when he resigned that office to become a director of the company. Mr. Probyn was also on the boards of John Garrington & Sons, Limited, and the Skinningrove Iron Company, Limited.

BY THE DEATH of Mr. Allen Jones, of 11, Park Crescent, Wigan, at the age of 76, the Wigan foundry trade has lost an outstanding figure. He served his apprenticeship at a foundry in Acrefair, and was afterwards employed at Liverpool, London and Derby. In 1883 he went to Wigan as foreman in the machine department at Messrs. Walker Bros., Pagefield Ironworks, and retired just prior to the war, when the employés presented him with a gold watch. He was specially requested to return to Messrs. Walker Bros. during the war to assist in the making of munitions. He also trained a large number of members of the Royal Flying Corps in mechanical instruction at the Wigan Mining and Technical College.

Contracts Open.

Alexandria, Egypt, November 1.—(a) Supply and erection of steel and iron work for lock, regulator, swing bridge and subsidiary works, for the Irrigation Department of the Ministry of Public Works. The Chief Inspecting Engineer, Egyptian Government, 41, Tothill Street, Westminster, S.W.1. (Fee, 12s. 6d., non-returnable.)

Darlington, September 14.—Iron and steel ware (including cogs, nails, etc.); cast-iron pipes, and miscellaneous castings, for six months ending March 31, 1927, for the Corporation. The Borough Surveyor and Water Works Engineer, Town Hall, Darlington.

East Harptree, September 6.—Construction of a tank and laying of about 163 yards of 1½-in. galvanised pipe, for the Clutton Rural District Council. Mr. W. T. Hawker, Council House, Temple Cloud, near Bristol.

Englefield Green, Surrey, September 6.—Iron staircase, for the Windsor Board of Guardians. Mr. J. E. Gale, clerk, 16, Sheet Street, Windsor.

Newton Abbot, September 7.—1,500 yards of 6-in., 1,300 yards of 4-in., and 500 yards of 3-in. cast-iron water mains, etc., for the Newton Abbot Rural District Council. The Council's Surveyor, 12, Summerland Street, Newton Abbot. (Fee, £2 2s., returnable.)

Stoke-on-Trent, September 6.—(7) Cast-iron work, for six months ending March 31, 1927, for the City Council. The City Surveyor, Town Hall, Stoke-on-Trent.

Melbourne, October 27.—One concrete slab-making machine (Contract No. 39,578), for the Victorian Government Railways Commissioners. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. A.X. 3468.)

Sydney, N.S.W., October 15.—Two electrically operated overhead travelling cranes, each of 100 tons capacity (Contract No. 1,033), for the Municipal Council of Sydney. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1., quoting Reference A.X. 3467.

Company Reports.

United Flexible Metallic Tubing Company, Limited.—Interim dividend of 2½ per cent., less tax.

Milnors' Safe Company, Limited. — Dividend of 7½ per cent. per annum, less income-tax, for year ended May 31 last.

Scottish Iron & Steel Company, Limited.—Dividend on 6 per cent. preference shares for half-year to June 30 last.

Brightside Foundry and Engineering Company, Limited.—Profit £9,380, brought forward £770, making £10,150. Dividend of 4 per cent., less tax, on ordinary. Carried forward £4,700. Dividend last year was 3 per cent., tax free.

Walter Scott, Limited.—Net trading loss of £13,710, plus £25,698 brought forward, making £39,409. To this falls to be added directors' fees, £1,000, and interest on 4 per cent. debenture stock for the year to June 30, 1926, £12,000, giving a total of £52,409.

British Empire Steel Corporation, Limited. — The operations of the several constituent companies and their subsidiaries during 1925 resulted in a loss of about £233,000, which added to the deficit brought forward, produced an adverse balance of just over £500,000, additions to which for depreciation, depletion, and interest on bonds and debentures bring the deficit on operations since the inception of the Corporation to a total of about £1,180,000. The report states that the Halifax shipyard has been unable to meet European prices for new ships, and as British-built ships under British register are permitted to enter the Canadian coasting trade without payment of duty, this shipbuilding plant was without any new construction during the year. Repair work was sufficient, however, to show a small increase in the profits over 1924.

Wills.

BATT, MR. FREDERICK EDMUND, of Ecclesall Road, Sheffield (net personalty £4,077) £4,449

HORNSBY, MR. JOHN HENRY JAMES, of Cuckfield Park, Sussex, a partner in the engineering firm of Messrs. Rushton & Hornsby (net personalty £96,682) £97,751

WHALLEY, MR. HARRY LESLIE, of Rosthorne, Duchy Road, Harrogate, managing director of the Hope Foundry, Leeds, and a director of Messrs. Fairburn, Lawson, Coombe, Barbour (net personalty £7,634) £8,162

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CUPOLAS, GANISTER, LOAM AND SAND MILLS, STUDS, CHAPLETS, BRUSHES, CORE ROPES. BUCKETS, SPADES, Etc.

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FOUNDRY. No. 1, No. 3, No. 4. } STANDARD GRADES { HEMATITE. No. 1, No. 3. No. 4.
Works:— Newmains, Lanarkshire.
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Office:— 75, Bothwell St., Glasgow, C.2.

IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—Following the usual race-time holiday on Tees-side, business in the Cleveland iron markets was resumed last week, but, so far as actual transactions were concerned, with but very indifferent results, the situation in the coal dispute still remaining too indistinct to open up prospects of an early revival of normal activity in the iron trade, at all events until the autumn is further advanced. The chief factor in the position at present is, of course, the difficulty of forecasting the exact trend of prices when furnaces are again in operation, this important and essential point depending practically on the figure at which fuel will be obtainable when a final settlement of the dispute is reached. At the same time there is likely to be a sharp home demand, which it will be difficulty to satisfy.

Although quotations remain unchanged, hematite is firmer than a week ago. Stocks have been substantially reduced, and there is now only one works in the whole north-eastern area turning out any iron at all. Mixed numbers now stand at 82s. 6d. per ton, and No. 1 83s. per ton. On the North-West Coast also prices are unchanged, with Bessemer mixed numbers £4 4s. per ton c.i.f. Welsh ports, £4 8s. per ton delivered at Glasgow, £4 12s. per ton delivered at Sheffield, and £5 per ton delivered at Birmingham.

LANCASHIRE.—In the uncertain conditions now generally prevailing in the iron trade, few attempts at either buying or selling can be reported, but it would appear that Derbyshire makers who are now quoting forward have secured some additional local orders, but they are of a hand-to-mouth character, and there is no expectation of important contract bookings until the price position generally is less obscure. For prompt the only iron now available is some Scottish No. 3 foundry, the quotation for which rules about 107s. 6d. per ton delivered.

THE MIDLANDS.—In the Birmingham market recently supplies of Continental pig have eased the situation somewhat, and it is reported that further large quantities of this iron are due for this month. The price has varied (according to quality and period of booking) from 87s. 6d. to 97s. 6d. per ton delivered here. It is still possible to obtain supplies of Middlesbrough Nos. 3 and 1 at 106s. 6d. and 109s. 6d. per ton respectively, delivered stations or sidings in this area.

SCOTLAND.—The general quotation for No. 3 Scotch foundry pig-iron is now 90s. per ton at furnaces, but, as might be expected, at this level consumers are only buying in small quantities. Despite the fuel difficulties, founders in general are still able to carry on, in some cases depending entirely on foreign coal, coke and pig-iron

Finished Iron.

Although in some of the more favoured districts, where coal-getting has been partially resumed, manufacturing firms have returned to working conditions, the majority of mill and forge plants is still handicapped by the shortage of cheap fuel, the essential factor in profitable production in all branches of industry. Consequently, business in most classes of finished material is quiet. It is, however, reported that two of the ironworks in Staffordshire are hoping to start up their mills immediately; of course, it will be in a restricted fashion, but it will be something accomplished, and they will have little trouble in getting all the business they require.

Scrap.

Reports from the various centres of the trade in scrap metal disclose little variation in the position as previously outlined, and with the exception of materials for foundry consumption, business everywhere may be pronounced as stagnant. On the North-East Coast, machinery qualities of cast-iron scrap, in handy pieces, are now quoted at 72s. 6d. per ton, and ordinary descriptions at 69s. per ton, both delivered at works. In South Wales, several of the local foundries have been able to continue working, but their consumption of good machinery cast-iron scrap is not large, and supplies are offered at 60s. to 65s.

Metals.

Copper.—Fluctuations in copper values of late, though confined within narrow limits, have inclined to slightly lower levels, due, possibly, to reactionary movements in the New York market, but unlikely to disturb the general steadiness of the position on this side. There does not seem to be any reason for anxiety as to the general outlook, for consumption in the United States seems to have increased in most trades in which this commodity is used, and the wise practice of keeping output under control will further assist in maintaining a sound position.

Official closing prices of standard copper have been as follow :—

Cash : Thursday, £58 10s. to £58 12s. 6d.; Friday, £59 to £59 2s. 6d.; Monday, £59 5s. to £59 7s. 6d., Tuesday, £59 2s. 6d. to £59 5s.; Wednesday, £59 2s. 6d. to £59 5s.

Three Months : Thursday, £59 5s. to £59 7s. 6d.; Friday, £59 15s. to £59 17s. 6d.; Monday, £60 to £60 2s. 6d.; Tuesday, £59 17s. 6d. to £60; Wednesday, £59 17s. 6d. to £60.

Tin.—Pending the issue of the statistical returns for the past month, business in this section of the metal markets appears to have been on a more subdued scale than of late, probably subject to holiday influences usual at this period of the year. Opinion seems to favour further increases in tin values, as demand still keeps up to the recent level of business, and stocks of this metal are said to be now becoming rapidly depleted.

Official closing prices of standard tin have been as under :—

Cash : Thursday, £293 to £293 2s. 6d.; Friday, £293 5s. to £293 10s.; Monday, £294 12s. 6d. to £294 15s.; Tuesday, £295 5s. to £295 10s.; Wednesday, £295 10s. to £295 15s.

Three Months : Thursday, £288 10s. to £288 12s. 6d.; Friday, £288 15s. to £289; Monday, £290 15s. to £291; Tuesday, £291 15s. to £291 17s. 6d.; Wednesday, £292 5s. to £292 10s.

Spelter.—Although for a time a rather easier tone has been evident on the London market, trade rallied last week to some extent, and a firmer position is expected in the near future. Galvanisers in this country are relying on supplies of foreign coal and steel in order to carry on, but despite this handicap they are overcoming their difficulties, although production of necessity is curtailed to considerably below the normal level.

The following are the week's prices :—

Ordinary : Thursday, £34 1s. 3d.; Friday, £34 7s. 6d.; Monday, £34 8s. 9d.; Tuesday, £34 12s. 6d.; Wednesday, £34 10s.

Lead.—With offerings of soft foreign pig in better volume than has recently been in evidence, and a rather weaker inquiry, the market has suffered a slight relapse in value, indicating apparently that consumers are well covered and have bought supplies more than sufficient for immediate use. Perhaps the report that arrivals so far this month have been considerably lighter will give an impetus to the demand, on the grounds of a possible shortage occurring.

The week's prices are appended :—

Soft foreign (prompt) : Thursday, £32 6s. 3d.; Friday, £32; Monday, £33 2s. 6d.; Tuesday, £33 7s. 6d.; Wednesday, £32 7s. 6d.

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Yours faithfully,
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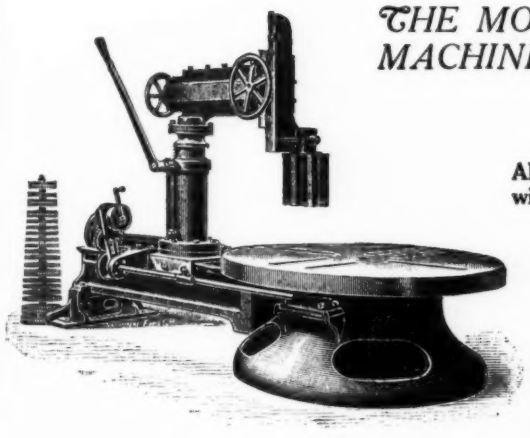

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WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	59	2	6
Three months ..	59	17	6
Electrolytic	67	0	0
Tough	65	0	0
Best selected ..	65	10	0
Sheets	90	0	0
India	73	0	0
Wire bars	67	10	0
Do. Sept.	67	5	0
Do. October ..	67	5	0
Ingot bars	67	5	0
H.C. wire rods ..	70	15	0
Off. av. cash, Aug.	58	18	4½
Do., 3 mths. Aug.	59	13	7½
Do., Sttlmnt. Aug.	58	17	7½
Do., Electro. Aug.	67	1	10½
Do., B.S., Aug. ..	66	0	10
Aver. spot price copper, Aug. ..	58	17	7½
Do., wire bars, Aug.	67	6	8
Solid drawn tubes			13d.
Brazed tubes ..			13d.
Wire			9¾d.

BRASS.

Solid drawn tubes ..	12d.
Brazed tubes	13½d.
Rods, drawn	11½d.
Rods, extd. or rlld. ..	7½d.
Sheets to 10 w.g ..	10¾d.
Wire	10½d.
Rolled metal	9¾d.
Yellow metal rods ..	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets ..	8½d.

TIN.

	£	s.	d.
Standard cash ..	295	10	0
Three months ..	292	5	0
English	294	0	0
Bars	296	0	0
Straits	302	5	0
Australian		—	
Eastern	297	0	0
Banca		—	
Off. avr. cash, Aug.	293	16	1½
Do., 3 mths., Aug.	282	2	3½
Do., Sttlmt. Aug.	293	14	6½
Aver. spot., Aug.	293	14	6½

SPELTER.

	£	s.	d.
Ordinary	34	10	0
Remelted	33	15	0
Hard	29	5	0
Electro 99.9 ..	38	0	0
English	35	5	0
India	31	15	0
Zinc dust	43	0	0
Zinc ashes	16	0	0
Off. aver., Aug. ..	34	6	11½
Aver., spot, Aug.	34	3	5½

LEAD.

	£	s.	d.
Soft foreign ppt.	32	7	6
English	33	15	0
Off. average, Aug.	32	11	0½
Average spot, Aug.	32	15	1½

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	42	15	0
Do. V.M. ex whf.	39	15	0
Rods	45	0	0
Boiler plates ..	39	0	0
Battery plates ..	38	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	74	10	0
Chinese	65	0	0
Crude	40	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver ..	15	5	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon	
25%	£9 0 0
45/50%	£10 0 0
75%	£17 0 0
Ferro-vanadium—	
35/40% ..	15/- lb. va.
Ferro-molybdenum—	
70/75% c. free ..	5/6 lb.
Ferro-titanium—	
23/25 carbonless	11½d.
Ferro-phosphorus, 20/25%,	£17 0 0
Ferro-tungsten—	
80/85%, c.fr. ..	1/4½ lb.
Tungsten metal powder—	
98/99% ..	1/10½ lb.
Ferro-chrome—	
2/4% car. ..	£33 0 0
4/6% car. ..	£22 0 0
6/8% car. ..	£21 5 0
8/10% car. ..	£20 10 0
Ferro-chrome—	
Max. 2% car.	£37 0 0
Max. 1% car.	£43 10 0
Max. 0.70% car.	£54 10 0
70%, carbonless	1/5½ lb.
Nickel—99% cubes or pellets ..	£170
Cobalt metal—98/99%	10/- lb.
Aluminium 98/99%	£118
Metallic Chromium—	
96/98% ..	3/3 lb.
Ferro-manganese (net)—	
76/80%, loose	£14 0 0
76/80%, packed	£15 0 0
76/80%, export	£14 0 0
Metallic manganese—	
94/96%, carbonless	2/- lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

	s.	d.
Finished bars, 14% tungsten ..	2	6
Finished bars, 18% tungsten ..	3	0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. and over ..	4d. lb.
Rounds and squares under ½ in. to ¼ in.	3d. lb.
Do. under ¼in. to ⅛ in.	1/- lb.
Flats, ½in. × ¼in. to under 1 in. × ⅛ in.	3d. lb.
Do. under ½in. × ¼in.	1/- lb
Bevels of approved sizes and sections	6d. lb.
Bars cut to length	10% extra
Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Hvy. steel	2	7	6	to 2	12	6
Bundled steel & shrngs.	2	2	6	to 2	5	0
Mixed iron & steel ..	2	2	6	to 2	5	0
Heavy cast iron	3	0	0			
Good machinery for foundries ..	3	5	0			
Cleveland—						
Heavy steel ..	3	9	0			
Steel turnings ..	2	6	0			
Cast iron borings	2	5	0			
Heavy forge ..	4	2	6			
Bushelled scrap	3	10	0			
Cast-iron scrap	3	8	6	to 3	10	0
Lancashire—						
Cast-iron scrap	3	2	6	to 3	10	0
Hvy. wrought ..	3	2	6			
Steel turnings ..	2	2	0			

London — Merchants' buying prices delivered yard.

Copper (clean) ..	49	0	0
Brass (clean) ..	39	0	0
Lead (less usual draft)	28	10	0
Tea lead ..	24	10	0
Zinc	23	0	0
New aluminium cuttings ..	80	0	0
Braziery copper	45	0	0
Gunmetal ..	46	0	0
Hollow pewter	190	0	0
Shaped black pewter ..	138	0	0

PIG-IRON.

(*f.o.t. unless otherwise stated*).

N.E. Coast—	
Foundry No. 1 ..	93/-
Foundry No. 3 ..	90/6
Foundry No. 4 ..	89/6
Forge No. 4	89/-
Hematite No. 1 ..	83/-
Hematite M/Nos. ..	82 6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	88 6
„ d/d Birm.	100/-
Midlands—	
Staffs common* ..	—
„ No. 4 forge ..	—
„ No. 3 foundry	—
Shrops. basic	—
„ Cold blast, ord.*	—
„ „ roll iron* ..	—
* d/d Birmingham.	
Northants forge	—
„ fdry No. 3 ..	—
Derbyshire forge ..	—
„ fdry. No. 3 ..	—
„ basic	—
Scotland—	
Foundry No. 1 ..	—
„ No. 3 ..	9 /-
Hem. M/Nos.	—
Sheffield (d/d district)—	
Derby forge	—
„ fdry. No. 3 ..	—
Lincs. forge	—
„ fdry. No. 3 ..	—
E.C. hematite	95/-
W.C. hematite ..	92/-
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 2 ..	—
Northants foundry No. 3	—
Dalzell, No. 3	110/-
Summerlee, No. 3 ..	107/6
Glengarnock, No. 3 ..	107/6
Gartsherrie, No. 3 ..	107/6
Monkland No. 3	107/6
Coltness, No. 3	107/6
Shotts, No. 3	107/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

	£	s.	d.	£	s.	d.
Iron—						
Bars (cr.) nom. ..	11	10	0	to 13	0	0
Angles				12	0	0
Tees to 3 united ins.				12	10	0
Nut and bolt				—		
Hoops				14	10	0
Marked bars (Staffs.) f.o.t. ..				14	0	0
Gas strip				12	10	0
Bolts and nuts .. ¾ in. × 4 in. ..				15	5	0
Steel—						
Ship plates				8	2	6
Boiler plts. ..				11	5	0
Chequer plts. ..				9	10	0
Angles ..	7	7	6	to 7	10	0
Tees ..	8	7	6	to 8	10	0
Joists ..	7	7	6	to 7	10	0
Rounds and Squares 3 in. to 5½ ins. ..				9	0	0
Rounds under 3 in. to ¾ in.				8	12	6
Flats, over 5 in. wide and up ..				9	10	0
Flats, 5in. to 1½in.				8	10	0
Rails, heavy ..				8	10	0
Fishplates				12	10	0
Hoops (Staffs.) ..				10	10	0
Black sheets, 24g.				11	5	0
Galv. cor. sheets, 24g.				16	15	0
Galv. fencing wire 8g. plain				12	10	0
Billets, soft ..				—		
Billets, hard ..				8	2	6
Sheet bars				—		
Tin bars d/d ..				6	5	0

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to w.g.	1	3½
Wire	1	3½
Rods	1	3
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free

10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.

C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks ..	9d. to 1/5½
Ingots rolled to spoon size ..	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols
No. 2X foundry, Phila.	21 76
No. 2 foundry, Valley	19.26
No. 2 foundry, Birm.	21.00
Basic	19.26
Bessemer	19.76
Malleable	19.26
Grey forge	18.76
Ferro-mang. 80% d/d	88.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars ..	36.00
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.22
Steel bars	2.00
Tank plates	1.90
Beams, etc.	2.00
Skelp, grooved steel ..	1.90
Skelp, sheared steel ..	1.90
Steel hoops	2.50
Sheets, black, No. 28 ..	3.10
Sheets, galv., No. 28 ..	4.25
Sheets, blue an'l'd, 9 & 10	2.30
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv. ..	3.35
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
„ furnace	—
Durham & North.	
„ foundry	—
„ furnace	52/6
Other Districts, foundry	—
„ „ furnace (basis)	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	24/-
„	28×20, „	49/-
„	20×10, „	—
„	18¾×14, „	—
C.W.	20×14, „	21/6
„	28×20, „	—
„	20×10, „	—
„	18¾×14, „	—

Terneplates 28×20, — per box basis f.o.b.

SWEDISH IRON.

Bars, hammered	£18/10 to £19/0
Rolled Ord.	£15/10/0 to £16
Nail rods	£16 5 0 to £16 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£9 to £12
Pig-iron	£6 0 0 to £6 10

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes	*Fittings*
Gas	60%	50%
Water	55%	45%
Steam	50%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.	
Aug. 26	58	10	0	dec. 2/6
,, 27	59	0	0	inc. 10/–
,, 30	59	5	0	,, 5/–
,, 31	59	2	6	dec. 2/6
Sept. 1	59	2	6	No change

Electrolytic Copper.

	£	s.	d.	
Aug. 26	66	5	0	dec. 5/–
,, 27	66	10	0	in . 5/–
,, 30	67	0	0	,, 10/–
,, 31	67	0	0	No change
Sept. 1	67	0	0	,, ,,

Standard Tin (Cash).

	£	s.	d.	
Aug. 26	293	0	0	No change
,, 27	293	5	0	inc. 5/–
,, 30	294	12	6	,, 27/6
,, 31	295	5	0	,, 12/6
Sept. 1	295	10	0	,, 5/–

Tin (English ingots).

	£	s.	d.	
Aug. 26	292	0	0	inc. 20/–
,, 27	292	0	0	No change
,, 30	293	10	0	inc. 30/–
,, 31	294	0	0	,, 10/–
Sept. 1	294	0	0	No change

Zinc Sheets (English).

	£	s.	d.	
Aug. 26	42	15	0	No change
,, 27	42	15	0	,, ,,
,, 30	42	15	0	,, ,,
,, 31	42	15	0	,, ,,
Sept. 1	42	15	0	,, ,,

Spelter (ordinary).

	£	s.	d.	
Aug. 26	34	1	3	inc. 2/6
,, 27	34	7	6	,, 6 3
,, 30	34	8	9	inc. 1/3
,, 31	34	12	6	,, 3 9
Sept. 1	34	10	0	dec. 2/6

Lead (English).

	£	s.	d.	
Aug. 26	33	15	0	No change
,, 27	34	5	0	inc. 10/–
,, 30	34	5	0	No change
,, 31	34	5	0	,, ,,
Sept. 1	33	15	0	dec. 10/–

AVERAGE MONTHLY PRICES PER UNIT OF MANGANESE ORE.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1914	10	9½	9½	9½	9.55	9½	9½	*	*	11.9	11.5	11.5	11.07
1915	1 0.3	1 2.63	1 4	1 4	1 8	1 9.88	1 10½	1 8.63	1 8	1 8	1 10.15	2 3.8	1 8.31
1916	2 7½	2 8	2 8	2 7½	2 6	2 6	2 6	2 6	2 7.6	2 8	*	*	2 7.08
1917													
1918			Prices pro hibited.										
1919					2 1½	*	2 2½	2 2.3	2 3.13	2 4.4	2 6½	2 7½	2 4.08
1920	2 11.8	3 6½	3 11½	4 1.8	4 5½	4 5½	4 3	4 1.13	4 0	3 9½	3 7½	2 10.7	3 10.19
1921	2 3.63	2 0½	1 8½	1 5.1	1 4½	1 2½	1 2½	1 2.13	1 1.7	1 2½	1 1.94	1 2.06	1 5.15
1922	1 1.63	1 1.44	1 1.1	1 1	1 1.25	1 1.7	1 2.31	1 2.13	1 2.1	1 2.13	1 2.63	1 2.95	1 1.86
1923	1 3.63	1 6.38	1 9.3	1 9½	1 10	1 10	1 9½	1 9	1 9	1 9.13	1 9	1 9½	1 7.89
1924	1 10.88	1 11.2	1 11	1 11½	2 0	1 11½	1 11⅝	1 11	1 10½	1 10½	1 10	1 9½	1 10.94
1925	1 10	1 10	1 10½	1 11	1 11	1 10½	1 9½	1 8½	1 8½	1 7½	1 8½	1 8½	1 9½
1926	1 8½	1 7½	1 8	1 7½	1 5½	1 5½	1 5½	1 4½	—	—	—	—	1 6½

* Not quoted.

AVERAGE MONTHLY PRICES OF FERRO-MANGANESE (80 PER CENT.)

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1914	9 12 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	11 0 0	12 5 0	11 6 3	10 7 6	10 7 6	9 10 8½
1915	11 0 6	12 10 0	14 10 0	15 0 0	17 15 0	20 0 0	20 0 0	20 0 0	20 0 0	20 0 0	20 0 0	20 0 0	17 11 3½
1916	20 0 0	22 10 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	52 0 0	25 0 0	25 0 0	25 0 0	23 10 10
1917	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0
1918	25 0 0	26 10 0	25 0 0	*	*	*	*	*	*	*	*	*	25 10 0
1919	*	*	*	*	25 0 0	25 0 0	25 0 0	25 0 0	25 0 0	24 10 0	23 0 0	25 10 0	24 14 3
1920	27 18 0	30 0 0	31 17 6	35 0 0	37 0 0	37 0 0	37 0 0	37 0 0	37 0 0	37 0 0	36 10 0	33 16 0	34 15 1½
1921	31 0 0	27 5 0	23 12 6	21 18 0	21 0 0	18 0 0	18 0 0	18 0 0	17 2 0	16 0 0	15 0 0	15 0 0	20 3 1½
1922	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0	15 0 0
1923	15 0 0	15 0 0	16 0 0	17 5 0	18 0 0	18 0 0	18 0 0	18 0 0	18 0 0	17 15 0	17 0 0	17 0 0	17 1 8
1924	17 0 0	17 0 0	17 0 0	17 0 0	17 0 0	17 0 0	16 10 0	14 10 0	13 10 0	13 10 0	14 3 4	14 15 0	15 14 10½
1925	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0	15 10 0
1926	15 10 0	15 10 0	15 9 0	15 0 0	15 0 0	15 0 0	15 0 0	14 5 0	—	—	—	—	15 1 9

* Not quoted.

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18, BENNETTS HILL, BIRMINGHAM.
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SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN. LEAD, SPELTER, ANTIMONY, CHROME ORE

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ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 7 words per line. Minimum charge for one insertion 3/-.

SITUATIONS VACANT AND WANTED.

ADVERTISER, progressive organiser, with long practical experience of Foundry, Pattern Shop and general Engineering, desires management of small works, or responsible position with larger firm.—Replies to Box 790, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

ADVERTISER desires change; 22 years' experience foundry pattern shop, also machine shop, as Foreman, Draughtsman, Checker, and Chief Inspector; alive to modern methods of mass production, chiefly aluminium and iron motor cylinders.—Box 802, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

COMMERCIAL MANAGER of large Malleable Ironfoundry, shortly terminating present engagement, desires responsible position with progressive foundry.—Replies to Box 798, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2

FOUNDRY MANAGER, aged 38, disengaged October 31, seeks progressive position; present duties include control of foundry working on piecework system; output is varied and consists of all classes of Grey Iron, White Iron, Chilled Work and Malleable Castings; able to produce at competitive prices, mix to analysis, practical cupola experience.—Box 800, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

METALLURGIST required for Engineering Works in the West of Scotland to supervise the various Heat Treatment Departments, in which are handled a variety of Small Forgings, Carburised Machined Parts, Small Tools, etc.; applicants must have a thorough knowledge of the most up-to-date practice in heat treatment of all classes of steels, and should have actual experience in the application of scientific methods in operating heat treatment processes on a quantity production basis; give particulars of age, training and experience; the right man liberally treated.—Box 794, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

REQUIRED for South Africa, Secretary, with experience and thorough knowledge of steel works accounts.—Apply, UNION STEEL CORPORATION, 20, King William Street, E.C.

WANTED FOR INDIA, a first-class Foreman Moulder for Steel Foundry, making a large variety of Steel Castings, chiefly for Railway Rolling Stock. Applicants must have had experience in mass production from pneumatic and hand moulding machines, and be able to design their own plate patterns, etc., from engineers' drawings. A knowledge of sands and the manufacture of moulder's composition, core sands, etc., is essential. Good organiser and one tactful in handling labour. Salary Rs. 600 per month with house allowance of Rs. 100 per month. Three years' engagement with 2nd class passage out and home. Single man preferred.—Apply, giving full particulars of past experience and present employment, to No. 2,552, "Courier," Dundee.

YOUNG FOUNDRY ENGINEER wanted by a large firm in S.W. London. Applicants must be 22 to 25 years of age, have had college training and some practical foundry experience.—Write, stating age, experience, and salary required, to Box F. 699, c/o DAWSONS Advt. Offices, 118, Cannon Street, E.C.4.

PATENTS.

PATENT YOUR INVENTIONS, Trade-mark your Goods. Advice, Handbook and Cons. free.—B. T. KING, C.I.M.E. (Regd. Pat. Agent, G.B., U.S.A., and Can.). 146A, Queen Victoria Street, E.C.4. 38 years' refs. 'Phone 682 Central.

MACHINERY.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. BREALEY & COMPANY, LIMITED, Prospect Works, Hawksley Avenue, Sheffield.

AGENCIES.

GERMAN Chemical Works require GENERAL AGENT for the sale of their FOUNDRY UTENSILS; must be well introduced in the foundry industry of England.—Offers to F. G. T., 803, Rudolf Mosse, Frankfurt a/M (Germany).

MISCELLANEOUS.

CASTING FLUX for all non-ferrous Metals. Its use is a gain, not an expense.—Write to WILLIAM OLSEN, LIMITED, Hull.

PERFORATED STUD CHAPLETS.—All sizes and shapes: best tinned quality.—LAWSON WALTON & CO., LTD., Newcastle-on-Tyne.

PATTERNS.—Inquiries solicited; quotations by return; shop equipped with modern machinery; quick delivery.—CLEGHORN & COMPANY, Midland Pattern Works, Spring Gardens, Worcester. Phone 264.

Foundry Chemists. **Practical Foundry Advisors**

"Beecroft's Service"
begins where others fail.

We show you how to apply the analyses of your materials so as to reduce the cost of your castings and improve the quality.
Analysis and **Testing** conducted by **Certified Chemists.**

Prompt report—low fees.

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JEWRY STREET, ALDGATE, E.C.3.
Principal ... ... Geo. PATCHIN, A.R.S.M., M.I.M.M.
DEPARTMENT OF METALLURGY.

The following special course of instruction will be given during the 1st and 2nd terms (September to April) of the session 1926-27, commencing Monday, September 20th, at 7 p.m.

FOUNDRY PRACTICE.

By L. SINGLEHURST WARD, B.Sc., and A. F. GIBBS.

The course, which will consist of lectures, demonstrations and practical work in moulding and casting, is arranged for Metallurgists and those engaged in Engineering and Foundry Work and will be of value to those interested in the production of all classes of castings.

For details of the course apply at the Office of the Institute, or by letter to the Principal.

FOUNDRY REQUISITES.

Try our REFRACTORIES.

Ganister or Silica Bricks and Blocks (any shape or size).
Sands, Cements, Ganister.—*Let us have your enquiries.*

THE CLEVELAND MAGNESITE & REFRACTORY CO., LTD.,
Normanby Brickworks, Normanby, Eston, Yorks.

Two No. 0. BRITANNIA Jolters, pin lift type- - - - - - - each	£22
Two No. 1. BRITANNIA Jolters, pin lift type - - - - - - each	£38
Two Small MUMFORD plain Jolters, lift 4 cwt. - - - - - - - -	£12
42″×36″ heavy geared rumbling barrel -	£28
36″×24″ rumbling barrel, new - - -	£12
JACKMAN Git Cutter for brass castings	£36

All types and sizes of Fans sizes of Compressors kinds of Foundry Plant **in Stock**

BUY FROM ME AND SAVE MONEY.

ALEX. HAMMOND, *FOUNDRY MACHINERY MERCHANT,*
14, AUSTRALIA ROAD, SLOUGH.